United States Court of Appeals
for the
District of Columbia Circuit

TRANSCRIPT OF RECORD

FOR MR. JUSTICE GRONER

Patent Case

TRANSCRIPT OF RECORD

Court of Appeals of the District of Columbia

OCTOBER TERM, 1932

No. 5806

277

NOAH C. PEARCY AND WESTINGHOUSE ELECTRIC
& MANUFACTURING COMPANY, APPELLANTS,

vs.

CONWAY P. COE
~~THOMAS E. ROBERTSON~~, COMMISSIONER OF
PATENTS.

APPEAL FROM THE SUPREME COURT OF THE DISTRICT OF
COLUMBIA.

FILED OCTOBER 6, 1932.

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Court of Appeals of the District of Columbia

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vs.

THOMAS E. ROBERTSON, COMMISSIONER OF PATENTS, APPELLEE.

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INDEX.

	Original	Print
Caption	*a*	1
Bill	1	2
Answer	5	5
Amendment to answer	7	7
Fiat of Justice O'Donoghue	7	7
Final decree	8	7
Order allowing appeal and fixing bond	8	8
Memorandum: $50 deposit in lieu of undertaking on appeal.	8	8
Assignment of errors	9	8
Order extending time to file statement of evidence	10	10
Memoranda: Statement of evidence filed: statement of evidence signed	11	10
Designation of record	11	10
Clerk's certificate	12	11
Statement of evidence	13	12
Testimony of Dr. Dayton Ulrey	13	12
Patent 1,169,182	25	20
1,368,584	28	23
1,459,400	30	25
1,591,717	34	29
761,380	37	32
915,280	40	35
1,422,553	43	38
1,461,921	49	44
Appl. 694,028	52	47
Decision of board of appeals	70	63

JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., OCTOBER 31, 1932.

Court of Appeals of the District of Columbia

No. 5806.

Noah C. Pearcy et al., Appellant,

vs.

Thomas E. Robertson, Commissioner, &c.

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a Supreme Court of the District of Columbia.

In Equity.

No. 51620.

Noah C. Pearcy and Westinghouse Electric & Mfg. Company, Plaintiffs,

vs.

Thomas E. Robertson, Commissioner of Patents, Defendant.

United States of America,
District of Columbia, ss:

Be it remembered, That in the Supreme Court of the District of Columbia, at the City of Washington, in said District, at the times hereinafter mentioned, the following papers were filed and proceedings had in the above-entitled cause, to wit:

1 *Bill.*

Filed July 9, 1930.

In the Supreme Court of the District of Columbia.

In Equity.

No. 51620.

Noah C. Pearcy and Westinghouse Electric & Mfg. Company, Plaintiffs,

v.

Thomas E. Robertson, Commissioner of Patents, Defendant.

To the Honorable the Justices of the Supreme Court of the District of Columbia:

The plaintiffs for their bill of complaint allege:

1. That the plaintiff, Noah C. Pearcy, is a citizen of the United States and now a resident and inhabitant of Louisville, Kentucky, but formerly a resident of Wilkinsburg, Pennsylvania, and that plaintiff, Westinghouse Electric & Manufacturing Company, is a corporation of the State of Pennsylvania, having its principal place of business at East Pittsburgh in said state, and that the defendant, Thomas E. Robertson, Commissioner of Patents, is a citizen of the United States and an official resident of the District of Columbia.

2. That the jurisdiction of this Court depends upon the patent laws of the United States.

3. That the plaintiff, Noah C. Pearcy, on February 20, 1924, filed an application in due form, and in accordance with the requirements of the Patent Statutes and the Rules of Practice of the United States Patent Office, for Letters Patent on Space Current Devices, Serial No. 694,028, proffer of a copy of which is hereby made, which has never been abandoned and now contains claims 1 to 5, inclusive, as follows:

2 "1. A thermionic electrode comprising a heating element including a member of non-conducting refractory material, and a sintered mixture of metal particles and thermionically active particles in intimate contact with said refractory member.

"2. A thermionic electrode comprising a heating element including a substantially cylindrical member of refractory material, and a thermionically active sleeve in contact with said cylindrical member, said sleeve comprising a sintered mixture of nickel particles and particles of oxides of the alkaline earth metals.

"3. A thermionic electrode comprising a heating element including a substantially cylindrical member of refractory material, a metallic coating upon said member, a thermionically active sleeve in contact with said cylindrical member and fused to said coating, said sleeve comprising a sintered mixture of metal particles and thermionically active particles.

"4. A method of forming a cathode for electron-discharge tubes which consists of forming a tube of a mixture of which one component is a metal of a high melting point and threading said tube upon a heater comprising a wire of refractory metal.

"5. An electrical discharge tube enclosing a gaseous atmosphere and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles."

4. That the defendant, on the 4th day of April, 1930, by a decision of the Board of Appeals, of which he is a member, did erroneously deny to plaintiffs, the right to the above-recited claims 1 to 5, inclusive.

5. That the said Board of Appeals, in the said decision, considered claims 6 and 7, and held them to be unpatentable, but expressed willingness to admit them for purpose of appeal, the said claims being as follows:

"6. An electrical discharge tube enclosing a gaseous atmosphere of such a pressure that gas ions carry a substantial part of the current, and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles.

"7. An electrical discharge tube enclosing a gaseous atmosphere of such pressure that the discharge is substantially not a pure electron discharge, and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles."

6. That the plaintiff, Noah C. Pearcy, was the original, first and sole inventor of the improvement described and claimed in the said application for Letters Patent, Serial No. 694,028; that the said improvement was not known or used by others prior to his invention or discovery thereof, and was not patented or described in any printed publication, in this or in any foreign country, prior to his invention or discovery thereof, and not more than two years prior to the date of filing the aforesaid application; that the said improvement was not in public use or on sale in this country for more than two years prior to the date of filing of the said application and was not patented in any country foreign to the United States on an application or applications filed more than twelve months prior to the date of filing of the said application, and has not been abandoned.

7. That the plaintiff, Noah C. Pearcy, assigned his entire right, title and interest in and to the said application for Letters Patent and to the invention claimed therein, to the plaintiff, Westinghouse Electric & Manufacturing Company, before filing the same in the United States Patent Office.

8. That, on information and belief, said defendant has power to grant to the plaintiffs the said claims denied to them by the aforesaid decision of the Board of Appeals of the United States Patent Office.

Wherefore plaintiffs pray for a decree by this court,
judging that they are entitled, according to law, to
4 receive a patent for the invention, as specified in
the said claims 1 to 7, inclusive.

Respectfully,

WESLEY G. CARR,
Attorney for Plaintiffs.

WGC:DAK.

East Pittsburgh, Pa., June 23, 1930.

RAYMOND JONES.

Verification.

* * * * * * *

State of Pennsylvania,
County of Allegheny, ss:

Wesley G. Carr, being duly sworn, deposes and says that he is the attorney in the above-entitled action; that he has read the foregoing Bill of Complaint and knows the contents thereof, and that the same is true to his own knowledge, except as to the matters therein stated to be upon information and belief, and as to those matters he believes it to be true.

WESLEY G. CARR,
Attorney for Plaintiffs.

Subscribed and sworn to before me this 3rd day of July, 1930.

[SEAL.] E. E. LITTLE,
Notary Public, East Pittsburgh, Pa.

My commission expires March 7, 1933.

5 ### *Answer.*

Filed July 29, 1930.

* * * * * * *

To the Honorable the Judges of the Supreme Court of the District of Columbia:

1. Defendant answering the Bill of Complaint admits for the purpose of this suit the allegations of paragraph 1.
2. Defendant admits that jurisdiction is conferred by Section 4915 R. S.; 35 U. S. C. A. 63.
3. Defendant admits the allegations of paragraph 3 with reference to application Serial No. 694,028.
4. Defendant admits that the Board of Appeals did deny to plaintiffs the right to the claims recited in paragraph 3, but denies that said denial was erroneous.
5. Defendant admits the allegations of paragraph 5.
6. Defendant admits that the plaintiff, Noah C. Pearcy, filed an application which was given Serial No. 694,028, in which he made the allegations specified in paragraph 6.
7. Defendant admits the allegations of paragraph 7.

8. Defendant admits that he has the jurisdiction specified in paragraph 8, but denies that the claims, 1 to 7, inclusive, for which plaintiffs contend, are patentable to them in view of the following prior patents, viz:

Nicolson, 1,169,182, Jan. 25, 1916;
Torrisi, 1,368,584, Feb. 15, 1921;
Hocker, 1,459,400, June 19, 1923;
Marden, 1,591,717, July 6, 1926;
Thowless, 844,213, Feb. 12, 1907,

and also the publication—

"Gas-Filled Thermionic Tubes," by Albert W. Hull, presented at joint New York Meeting of New York Sections of the A. I. E. E. and the I. E. S., May 18, 1928.

Profert of copies of said patents and said publication is hereby made.

6 Further answering, defendant denies that the claims set forth in paragraphs 3 and 4 of the Bill of Complaint are patentable to plaintiffs in view of the prior art specified in paragraph 8 of this answer, all of which more fully appears in the examiner's statement and the decision of the Board of Appeals, profert of which is hereby made.

And further answering, defendant denies each and every allegation of the Bill of Complaint not herein specifically and sufficiently denied or admitted, and prays that plaintiffs' Bill of Complaint be dismissed.

Wherefore defendant having fully answered the Bill of Complaint denies that plaintiffs are entitled to the relief demanded or any part thereof and prays that he be hence dismissed with all costs and expenses of the proceedings against the plaintiffs as required by Section 4915 R. S.

THOMAS E. ROBERTSON,
Commissioner of Patents, Defendant.

T. A. HOSTETLER,
Solicitor U. S. Patent Office,
Attorney for Defendant.

DISTRICT OF COLUMBIA,
City of Washington, ss:

I, Thomas E. Robertson, Commissioner of Patents, depose and say that I have read the above answer by me subscribed and know the contents thereof, and that the statements of facts therein made as upon personal knowledge are true, and those made upon information and belief I believe to be true.

THOMAS E. ROBERTSON,
Commissioner of Patents.

7 Subscribed and sworn to before me this 28th day of July, 1930.

[SEAL.] FANNIE W. SCHRIDER,
Notary Public, D. C.

My commission expires May 12, 1933.

Amendment to Answer.

Filed April 25, 1932.

* * * * * * *

And now comes the defendant, and by leave of Court first had, files the following amendment to his Answer to the Bill of Complaint in the above entitled cause:

After the list of patents cited in the Answer to paragraph 8, *add the following references:*

Heany, 761,380, May 31, 1904,
Fessenden, 915,280, May 16, 1909,
Friederich, 1,422,553, July 11, 1922,
Lederer, 1,461,921, July 17, 1923.

T. A. HOSTETLER,
Solicitor for the Patent Office,
Attorney for Defendant.

April 25, 1932.

Amendment allowed.
DANIEL W. O'DONOGHUE,
Justice.

8 *Final Decree.*

Filed May 31, 1932.

* * * * * * *

This cause having come on to be heard and having been tried in open court and argued by counsel for the respective parties upon the pleadings and proofs adduced and submitted to the Court,

It is adjudged, ordered, and decreed this 31st day of May, 1932, that the Bill of Complaint in this case be, and the same is hereby dismissed.

DANIEL W. O'DONOGHUE,
Justice.

Approved as to form.
WESLEY G. CARR,
Attorney for Plaintiffs.

Order Allowing Appeal, &c.

Filed June 22, 1932.

* * * * * * *

Plaintiffs' appeal this day filed is hereby allowed and the appeal bond is fixed in the sum of One Hundred Dollars ($100 00/100), to be approved by the Court, or $50 cash may be deposited with the Clerk in lieu of bond.

JESSE C. ADKINS,
Justice.

June 22, 1932.

Memorandum.

June 23, 1932.—$50 deposit in lieu of undertaking on appeal.

9 *Assignment of Errors.*

Filed June 23, 1932.

* * * * * * *

Now come Noah C. Pearcy and the Westinghouse Electric & Manufacturing Company, the above-named Plaintiffs, by their solicitor, F. W. Lyle, and, having prayed an appeal to the Court of Appeals of the District of Columbia from the decree and order made and entered in this cause on the 21st day of May, 1932, say that said decree and order are erroneous and unjust and against the rights of said plaintiffs, and as Assignment of Error therein represent that the said Supreme Court of the District of Columbia erred in the following particulars:

1. In finding that they are not entitled, according to law, to receive a patent for the invention specified in claims 1 to 3 and 5 to 7, inclusive, of application for Letters Patent, Serial No. 694,028, on space current devices, filed February 20, 1924 by Noah C. Pearcy, and in not finding that these plaintiffs are entitled, according to law, to receive a patent for the inventions specified in the said claims 1 to 3 and 5 to 7, inclusive, of the said application for Letters Patent.

2. In giving undue and improper weight to the prior art adduced by Defendant.

3. In failing to find that the prior art patents are not entitled to be considered as disclosing the invention disclosed and claimed in the aforesaid application for Letters Patent.

4. In failing to find that the function of the invention specified in the said claims 1 to 3 and 5 to 7, inclusive, of the said application for Letters Patent was not inherent in, or capable of being effected by, the devices shown in the prior art patents.

5. In failing to find that the aforesaid application for Letters Patent disclosed novelty in the construction in which the invention specified in the said claims 1 to 3 and 5 to 7, inclusive, of the said application for Letters Patent is embodied; and that the said construction is not anticipated by the prior art patents.

6. In failing to find that the invention would be and/or was involved in combining to produce an anticipation of the combination specified in the said claims 1 to 3 and 5 to 7, inclusive of the said application for Letters Patent, structural elements shown separately in different prior art patents.

7. In failing to find that such structural elements as the prior art shows were subjected, when in the combination specified in the said claims 1 to 3 and 5 to 7 of the said application for Letters Patent, to conditions so different from those to which they were subject in the combinations in which they are found in the prior art that invention was involved in recognizing their adaptability to produce the results they effect in the combinations specified in the said claims 1 to 3 and 5 to 7.

8. In failing to find that the results produced by the combinations of structural elements specified in the said claims 1 to 3 and 5 to 7 of the said application for Letters Patent are superior to the results produced by any of the combinations shown by the prior art.

9. In dismissing plaintiffs' Bill of Complaint and in not sustaining it.

Wherefore the Plaintiffs pray that the said decree be reversed and the Supreme Court of the District of Columbia be directed to sustain the Bill of Complaint.

NOAH C. PEARCY AND
WESTINGHOUSE ELECTRIC AND
MANUFACTURING COMPANY,
By F. W. LYLE,
Attorney for Plaintiffs.

Order Extending Time to File Statement of Evidence.

Filed July 9, 1932.

* * * * * * *

Upon consideration of the motion by plaintiffs for an extension of time within which the statement of evidence may be filed, it is, this 9th day of July 1932 ordered, nunc pro tunc as of June 23 1932, that the time for filing said statement of evidence be and the same is hereby extended to and including July 16th 1932.

F. D. LETTS,
Justice.

11 *Memoranda.*

July 15, 1932.—Statement of Evidence filed.
August 19, 1932.—Statement of Evidence signed.

Designation of Record.

Filed July 12, 1932.

* * * * * * *

Under the provisions of Rule V, paragraph 2, Revised Rules of the Court of Appeals of the District of Columbia, it is hereby stipulated by and between counsel for appellant and appellee that the following enumerated papers shall constitute the transcript of record on appeal.

(1) Bill of Complaint.

(2) Answer.

(3) Amendment to Answer.

(4) Final Decree dated May 31, 1932.

(5) Order Allowing Appeal.

(6) Pages 2 to 8 of Exhibit 1 (Pearcy Application). Claims 1, 2, 3, 5, 6, 7 (i. e. pages 9 and 14 of Exhibit 1, and the single page of Exhibit 2).

(7) Defendant's Exhibits A, B, C, D, F, G, H, I, K, L, M.

(8) Statement of Dr. Dayton Ulrey's testimony for Plaintiff.

(9) Assignment of Errors.

(10) Order nunc pro tunc extending time for filing Statement of Evidence.

(11) Designation of the Record.

F. W. LYLE,
Counsel for Appellant.
T. A. HOSTETLER,
Counsel for Appellee.

July 12, 1932.

12 Supreme Court of the District of Columbia.

UNITED STATES OF AMERICA,
District of Columbia, ss:

I, Frank E. Cunningham, Clerk of the Supreme Court of the District of Columbia, hereby certify the foregoing pages numbered from 1 to 11, both inclusive, to be a true and correct transcript of the record, according to directions of counsel herein filed, copy of which is made part of this transcript, in cause No. 51620 in Equity, wherein Noah C. Pearcy et al. are Plaintiffs and Thomas E. Robertson, Commissioner of Patents, is Defendant, as the same remains upon the files and of record in said Court.

In testimony whereof I hereunto subscribe my name and affix the seal of said Court, at the City of Washington, in said District, this 3rd day of October, 1932.

[Seal Supreme Court of the District of Columbia.]

FRANK E. CUNNINGHAM,
Clerk.

13 In the Supreme Court of the District of Columbia.

Equity. No. 51620.

Noah C. Pearcy and Westinghouse Electric Company,
Plaintiff-Appellant,

vs.

Thomas E. Robertson, Commissioner of Patents,
Defendant-Appellee.

Statement of Evidence.

The subject matter in suit is the patentability to the plaintiffs of six claims (item 2 Transcript) covering an electron-emissive cathode for an electrical discharge tube described in plaintiffs' patent application (item 1 Transcript). The defendant produced no witnesses, merely offering in evidence as exhibits eight issued patents, the drawings of the plaintiffs' patent application, the Patent Examiner's Statement and the Decision of the Board of Appeals (item 3 Transcript). The plaintiffs produced a witness, Dr. Dayton Ulrey, who testified as to the technical features and advantages of the plaintiffs' cathode and as to features distinguishing it from the defendant's exhibits to the following effect.

Testimony on Behalf of the Plaintiffs by Dr. Dayton Ulrey.

Dr. Ulrey testified:

He has been a research physicist with the Westinghouse Electric and Manufacturing Company, one of the plaintiffs, since 1918; prior to which he taught physics in the University of Pittsburgh, having obtained his A. B. 14 degree from the University of Indiana in 1911, his Master's degree in 1912 and his Ph. D. degree in physics at Stanford University in 1917.

He is now in charge of the Physics Division of the Research Department, which handles, among other physical problems, all problems relating directly or indirectly to vacuum electric discharge devices and gas-filled electric discharge devices.

He directly supervised the work of the plaintiff, Noah C. Pearcy, for about two years, starting the early part of 1922, occupying the same laboratory room with Pearcy. He was well acquainted with the work of Pearcy which led up to the filing of the Pearcy application in suit.

Pearcy was experimenting with electrical discharge tubes and made a large number of tubes during these experiments, beginning with tubes which had a cathode comprising refractory core encasing a heater and surrounded by a nickel sleeve on which was deposited a thermionically-emissive coating of barium oxide and strontium oxide (Q. 10).

Pearcy's tubes differ from the types of electrical discharge tubes which are most commonly used commercially in that they were provided with a gaseous atmosphere which permitted them to handle much larger currents and with lower internal losses than would high vacuum tubes of the same dimensions (Q. 20, Q. 27).

15 When operated in a gaseous atmosphere, these tubes failed because of loss of electron emission, this resulting from disappearance or stripping off of the coating of oxides from the nickel sleeve shortly after being placed in operation (Q. 13). This led Pearcy to develop the type of cathode described in the application in suit, the purpose being to obtain an electron-emissive coating of satisfactorily long life.

The tubes first mentioned failed because the coating of barium and strontium oxides was completely torn off in not more than a day by the bombarding action of positive ions in the arc discharge (Q. 13, Q. 14).

Pearcy made cathodes, according with the application in suit (Q. 10), comprising refractory cores coated with a relatively thick (Q. 76, p. 46) sintered mixture of nickel powder with barium oxide and strontium oxide (Q. 11). "Sintered" means that the metal particles have been made to adhere together by heating just below melting point without added pressure (Q. 16).

He found nickel best for this purpose, since it does not oxidize easily like iron (Q. 16), and since it has, unlike noble metals such as platinum or tantalum, a comparatively low melting point which permits the mixture to sinter and make a solid adherent body (Q. 16).

Sintering has several distinct advantages.

(1) It produces a spongy mass in which the barium oxide and strontium oxide particles are imbedded
16 firmly (Q. 18).

(2) The emitting surface is largely increased compared with a solid coating of these oxides by reason of the presence of the pores and interstices (Q. 18).

(3) It has a good thermal conductivity and tends to distribute temperature inequalities and mitigate formation of hot spots (Q. 76, p. 46).

The additional surface provided by pores and interstices in Pearcy's sintered cathode surface constituted an effective electron-emitting surface because Pearcy's tubes were gas filled and would have been ineffective and of no advantage if the tube were of a high vacuum type (Q. 18).

17 A wide and universally recognized distinction exists between gaseous discharge tubes such as Pearcy's and vacuum tubes such as are universally used in radio receiving sets (Q. 27, Q. 43, Q. 44). Pearcy's gas pressure is 10,000 to 1,000,000 times as high as that of the ordinary radio vacuum tube (Q. 72, p. 43) and such gas as remains in the latter has no effect whatever upon the electrical discharge (Q. 72). In Pearcy's tube, positive ions neutralize what is known as space discharge of the electrons, thus permitting 10 or 20 volts to product currents of 1 or 2 amperes, whereas the same structure, evacuated as in ordinary radio tubes, could produce even 1/10 of an ampere only under the pressure of 400 or 500 volts (Q. 27.). Radio vacuum tubes would cease to function were gas such as Pearcy uses present in them; and Pearcy's tubes would not function for his purposes if he had a vacuum such as that in radio tubes (Q. 28). Radio tubes are invariably high-vacuum tubes, since gas, if present, would distort the signals and the tube would be useless (Q. 43, Q. 44). Their characteristics are "radically and essentially different" from gas-filled tubes (Q. 28, Q. 72) and the

> "requirements of the cathode are entirely different, because in the gas filled tube there is a very great tendency to disintegrate the cathode surface due to the positive ions falling into the cathode whereas in a vacuum tube the number

of ions falling in is so small as to make this tendency immaterial and not noticeable*. The loss of emission, therefore, from the cathode in a vacuum tube is from an entirely different reason than the loss of emission in a gas-filled tube'' (Q. 72).

18 A further difference of condition between cathodes of vacuum tubes and those of gas-filled tubes is that—

''any hot spots present on the cathode tend to become exaggerated in a gaseous atmosphere, whereas in a vacuum tube they tend to become minimized. The reason is this: A hot spot in a cathode—and by that I mean some part which is hotter than the rest of it—will give off more electrons than those parts at the lower temperatures, and since they give off more electrons, there is a higher negative charge around them than there is around the remainder, and therefore the positive ions tend to crowd into that area. Since more positive ions will fall into that hot spot, they will make it still hotter, and since making it hotter tends to make it give off more electrons, still more will tend to fall into it.''

''So that there is a condition of unstable equilibrium which is only balanced by the fact that the losses by radiation go up as the fourth power of the temperature. So that finally you get to a condition that the losses by radiation balance the increase in energy due to positive ions falling in, and it does not go farther.

But a cathode which has these hot spots is always one which will give unsatisfactory life as we ordinarily know it, because the evaporation loss of active material is a function of the temperature, and if we go to very high temperatures the life is very short.

Now, in a vacuum tube it is known that the emission of electrons produces a cooling effect, not large but yet measurable. So that the tendency of hot spots to give off more electrons tends to cool that particular spot instead of to heat it; so that you do not have the condition of unstable equilibrium mentioned before'' (Q. 76).

---

*The ion bombardment of the cathode in a radio tube is only between one-ten thousandth and one millionth of that on Pearcy's cathode (Q. 72). "As far as performance or life of the tube is concerned, we may say there are no ions in the vacuum tube" (Q. 112).

The presence of a refractory insulator or core, where such is used to support the electron-emissive surface of the cathode, also tends to produce and exaggerate hot spots on the cathode surface (Q. 76, p. 46), being a poor conductor of heat (Q. 92).

19 "In the Pearcy cathode there is little tendency for hot spots to develop, because of the relatively thick sintered mixture used for the surface. As a refractory insulator would tend to produce hot spots in this surface, the thermal conductivity of the coating is such that it will tend to distribute those inequalities and even the temperatures over the surface" (Q. 76).

Adverting to the references cited by the Defendant—Nicolson 1,169,182 (Exhibit A) shows a cathode comprising a refractory cylinder, 6, enclosing a heater, 7, and provided with an extremely thin coat of platinum somewhat like gold-plating on china, on which is placed a loose coating of barium, strontium and calcium oxides. In contrast to Pearcy's cathode coating comprising a "sintered mixture of nickel with oxide particles," Nicholson's (thermionically emissive) oxides are devoid of any binder and easily rubbed off (Q. 51, Q. 48). Nicolson's tube is a high-vacuum (telephone or radio relay) tube and could not be used for his purposes if gas-filled (Q. 48). Nicholson's thin platinum would have no effect in avoiding temperature inequalities over the cathode surface, whereas Pearcy's thick sintered coating would have a decided temperature equalizing effect (Q. 51).

20 Torrisi 1,368,584 (Exhibit B) shows a cathode comprising a refractory core, U, provided with a heater, C, and having a nickel coating or sleeve, A, and covered with a "loose and not adherent" barium-strontium-calcium oxide coating (Q. 52). Torrisi's tube is a high-vacuum tube and would have been useless for his purposes (radio amplifier) if gas-filled (Q. 52).

Both Torrisi and Nicolson fail as anticipations of Pearcy through having—

"no sintered mixture of metal particles and thermionically-emissive oxides as cathode surfaces, but only oxides without metal powder mixed in" (Q. 53).

Hocker 1,459,400 (Exhibit C) shows a cathode comprising a filament of platinum coated with particles of barium, strontium or calcium oxides (Q. 55). As an initial step in manufacture, Hocker mixes his oxides with particles of gold, platinum, or iridium, but these are practically completely vaporized by heating and there is when completed no mixture of metal with the oxides (Q. 55). Hocker has no refractory core (Q. 55), no sintered mixture of metal and oxide particles (Q. 55), and has purely a high-vacuum, not a gas-filled tube (Q. 55).

Marden 1,591,717 (Exhibit D) shows a cathode comprising a heater-filament coated with a mixture of barium-strontium (thermionically emissive) oxides with metallic (gold, platinum, silver) powder (Q. 56, p. 29). As
21 an alternative form he describes a cathode comprising a rod forged from the mixed oxide and metal powder, and having no separate heater or core (Q. 56, p. 29). Marden's cathode was for high-vacuum tubes, and would fail in a gas-filled tube (Q. 56, p. 30). In the cathode provided with a heater the metal particles are not sintered; the surface would be "irregularly", "non-uniformly heated" (Q. 56, p. 30) and so unlike Pearcy (Q. 56, p. 31); Marden has no refractory and this results in a voltage-drop from end to end of the cathode which would cause failure in a gas-filled tube (Q. 56, p. 30). Marden's cathode containing platinum powder would differ radically in gas-filled tube from Pearcy's sintered nickel powder and would be—

> "destroyed by positive-ion bombardment just about as easily as if there is no metal present" (Q. 58).

Marden's structure further differs from Pearcy in that the cathode coating of mixed oxides and metal is part of the heater (Q. 60), whereas Pearcy's coating does not function at all as a heater, being insulated from the heater by the refractory core (Q. 62).

Heany 761,380 (Exhibit F) shows, not a cathode, but an arc-lamp having electrodes comprising mixtures of particles of noble metal (i. e. gold, platinum, iridium) with some five oxides only one of which is used in thermionically-emissive cathodes and then only in combination with other

oxides not disclosed by Heany (Q. 64). His object in
22 using these oxides is to improve the light of the arc
by their vapor. His metal particles are not sintered (Q. 64). The electrodes operate in air at atmospheric pressure and the slightest trace of air in tubes of the Pearcy type kills cathode emission and makes the tube practically useless. (Q. 66, Q. 67).

Fessenden 915,280 (Exhibit G) describes a gas-filled tube intended for receiving the wireless signals of its day (1907) and provided with electrodes coated with barium-strontium (thermionically-emissive) oxides. The device is limited to minute currents, has no mixture of metal particles with the oxides and has no refractory (Q. 68).

Friederich 1,422,553 (Exhibit H) describes an arc-lamp having an electrode 6 which can be heated, and states that certain oxides may be placed in the neighborhood of the arc "in order to improve the light given out". At another point he describes the mixture of oxides with metallic tungsten constituting the electrode, but none of the oxides so named is thermionically emissive (Q. 69, p. 39). He discloses no thermionically-emissive material on the electrodes, nor one admixed or sintered with metal powder; nor any refractory (Q. 69, p. 40).

Lederer 1,461,921 (Exhibit I) shows a vapor-filled arc-lamp having an oxide-coated platinum filament. The cathode coating contains nothing but the usual barium-strontium oxides. There is no refractory, nor any sintered or other metal mixture. (Q. 70).

23 An engineer or physicist would, in his opinion, not naturally make the substitution of Marden's or Hocker's electron-emissive material for Nicolson's coating in order to secure the functions and results of Pearcy's application, because the latter—

> "were unrelated to the functions and results of the patents cited, and the factors affecting the life or performance of the cathode in the vacuum tubes, such as Hocker and Marden and Nicolson used, are entirely different from the factors which affect life and performance in the tube which Pearcy used" (Q. 71).

The disclosures of none of the patents discussed by him (Dr. Ulrey) shows the sponge-like structure embodied in

Pearcy's coating after sintering (Q. 75). None of the thin coatings described in the reference patents would tend to distribute inequalities and even the temperature of the cathode surface, as would Pearcy's thick sintered coating because thermal conduction is a function of thickness of material (Q. 76, p. 46).

The sintered nickel particles adhere and hold the oxide particles in plate (Q. 99); and none of the reference patents have similar mixtures (Q. 106, Q. 107) since their metals do not sinter and would have no effect in holding the oxide particles (Q. 105).

In other gaseous tubes, the ionic bombardment disintegrates the cathode and makes it wear out quickly, (Q. 120, Q. 121), while in Pearcy the sintered nickel enmeshes the oxides and withstands this bombardment (Q. 122) and stands up much longer than the other tubes tested by Pearcy before producing the one in suit (Q. 129).

24 Service of the foregoing condensed Statement of Evidence is hereby acknowledged this 16th day of July, 1932.

T. A. HOSTETLER,
Solicitor for Defendant.

The foregoing is a true and correct statement in substance of all the evidence offered on the hearing of the above-entitled cause on behalf of the parties plaintiffs and defendant as offered, given and received in Open Court, and the same is accordingly approved as such to become and be a part of the record on the appeal in the said cause, according to the provisions of the rule of Court in such case made and provided, this 19th day of August, 1932.

DANIEL W. O'DONOGHUE,
Justice.

A. McL. NICOLSON.
THERMIONIC TRANSLATING DEVICE.
APPLICATION FILED APR. 19, 1915.

1,169,182. Patented Jan. 25, 1916.

Fig. 1.

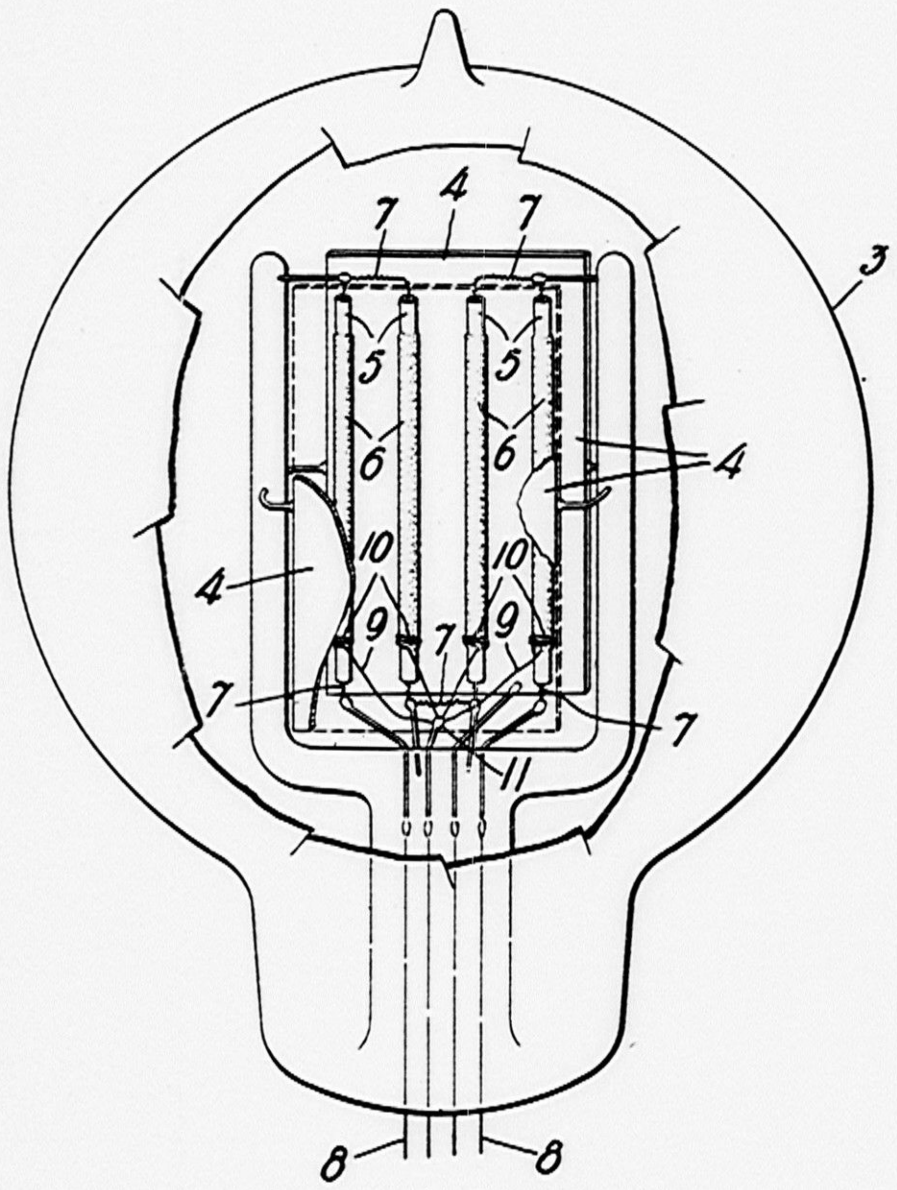
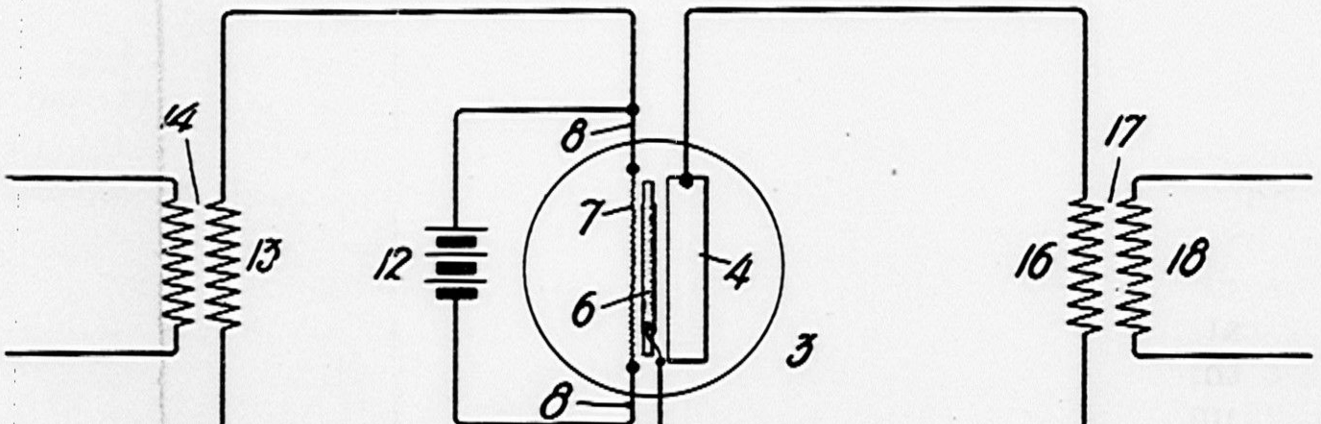


Fig. 2.



Witnesses:
O. D. M. Guthe.
John Waldheim

Inventor:
Alexander McLean Nicolson.
by John G. Roberts
Atty

UNITED STATES PATENT OFFICE.

ALEXANDER McLEAN NICOLSON, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTERN ELECTRIC COMPANY, INCORPORATED, A CORPORATION OF NEW YORK.

THERMIONIC TRANSLATING DEVICE.

1,169,182. Specification of Letters Patent. **Patented Jan. 25, 1916.**

Application filed April 19, 1915. Serial No. 22,306.

To all whom it may concern:

Be it known that I, Alexander McLean Nicolson, a subject of the King of Great Britain, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Thermionic Translating Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to thermionic translating devices and in particular to vacuum tube devices in which the cathode element is heated by radiation from an adjacent heating element, and its object is to produce a large current output with a minimum number of electrode elements.

In a copending application I have described a form of so-called equi-potential cathode element for use in a thermionic translating device, which element comprises a tube of quartz or similar material, the outer surface of which is given a thermionically active coating, which is brought to incandescence by means of an electrically heated resistance element located inside of the tube but out of electrical contact with the external coating. The present invention contemplates the employment of this resistance or heating element as the input electrode of a translating device, and is based on my discovery that the input electrode may be heated to incandescence without interfering with the operation of such a device.

The exact nature of this invention will be more clearly understood by reference to the accompanying drawing in which—

Figure 1 is a device of the audion type employing the cathode and input element arrangement of this invention, and Fig. 2 illustrates diagrammatically how the various electrodes of such a device may be connected into a typical circuit arrangement for the modification of telephonic or other currents.

In Fig. 1, 3 is an evacuated vessel, containing anodes or plates 4, and a plurality of quartz tubes 5 the outer surfaces of which have thermionically active coatings 6. A platinum spiral 7 is threaded through the tubes 5 in succession, as shown, and terminates on the two leading-in wires 8. The coating 6 is prepared as described in my copending application by first applying a layer of platinum tetra-chlorid to the outside of the tubes 5 and baking. This produces a platinum deposit which in turn is coated by a mixture of the oxids of strontium and barium or other suitable thermionically active material. Leading-in wires 9 may be conveniently attached to the coating 6 by wrapping one end of the wire 9 about said coating as shown at 10 and covering the joint thus formed with platinum tetrachlorid and baking. By connecting all of leading-in wires 9 to one terminal 11, the surface 6 may be made to function as a single cathode surface of large electron-emitting area, all parts of which surface can be maintained at the same potential with respect to the anodes 4. Such a cathode is therefore what may be called an equi-potential cathode as distinguished from the distributed potential cathode of the filamentary type customarily employed in audion devices.

In adapting such a device to use as an amplifier of telephonic currents, the terminals 8 of the platinum spiral 7 are connected to terminals of the battery 12 whose function it is to heat the spiral 7 to incandescence. The heating of this spiral causes a consequent incandescing of the cathode surfaces 6, making them thermionically active. In the diagrammatic arrangement of Fig. 2 one terminal 8 of the spiral 7 is connected to the secondary winding 13 of an input transformer 14 and serves therefore as an input electrode for the audion in place of the grid element customarily used.

In accordance with the well-known theory of operation of the audion, any variable electromotive force impressed by the winding 13 between the cathode 6 and the input electrode 7 varies the amount of space current flowing from the anode 4 to the cathode 6 by virtue of the battery 15. This variable current flowing through the winding 16 and the output transformer 17 produces in winding 18 an amplified current having the same frequency characteristics as the input current impressed on the winding 13. It is thus seen that the arrangement described provides a thermionic translating device having the advantages of an equi-potential cathode with only three electrode elements, and without the necessity of employing an additional heating element for the cathode surface. Inasmuch as the heating element employed is used also as an input element and is not located between the cathode surface and the anode in such a way as to shield the anode from any thermionic emissions from the cathode, it follows that an arrangement is provided which is capable of large current output.

What is claimed is:

1. In a thermionic translating device, a heated input electrode, and a cathode surface made thermionically active by heat radiation from said input electrode.

2. In a thermionic translating device, a thermionically active cathode surface and a heated electrode adjacent said surface and serving the double purpose of an input electrode and a heater for said surface.

3. A thermionic translating device comprising an evacuated vessel, a cathode and an input electrode within said vessel and means outside said vessel for incandescing said input electrode.

4. A thermionic translating device comprising an evacuated vessel, an equi-potential cathode within said vessel, an input electrode also within said vessel and in close proximity to said cathode, and means outside said vessel for heating said input electrode and thereby rendering said cathode thermionically active.

In witness whereof, I hereunto subscribe my name this 16th day of April, A. D. 1915.

ALEXANDER McLEAN NICOLSON.

23

S. S. TORRISI.
CATHODE FOR AUDIONS.
APPLICATION FILED JULY 10, 1918.

1,368,584. Patented Feb. 15, 1921.

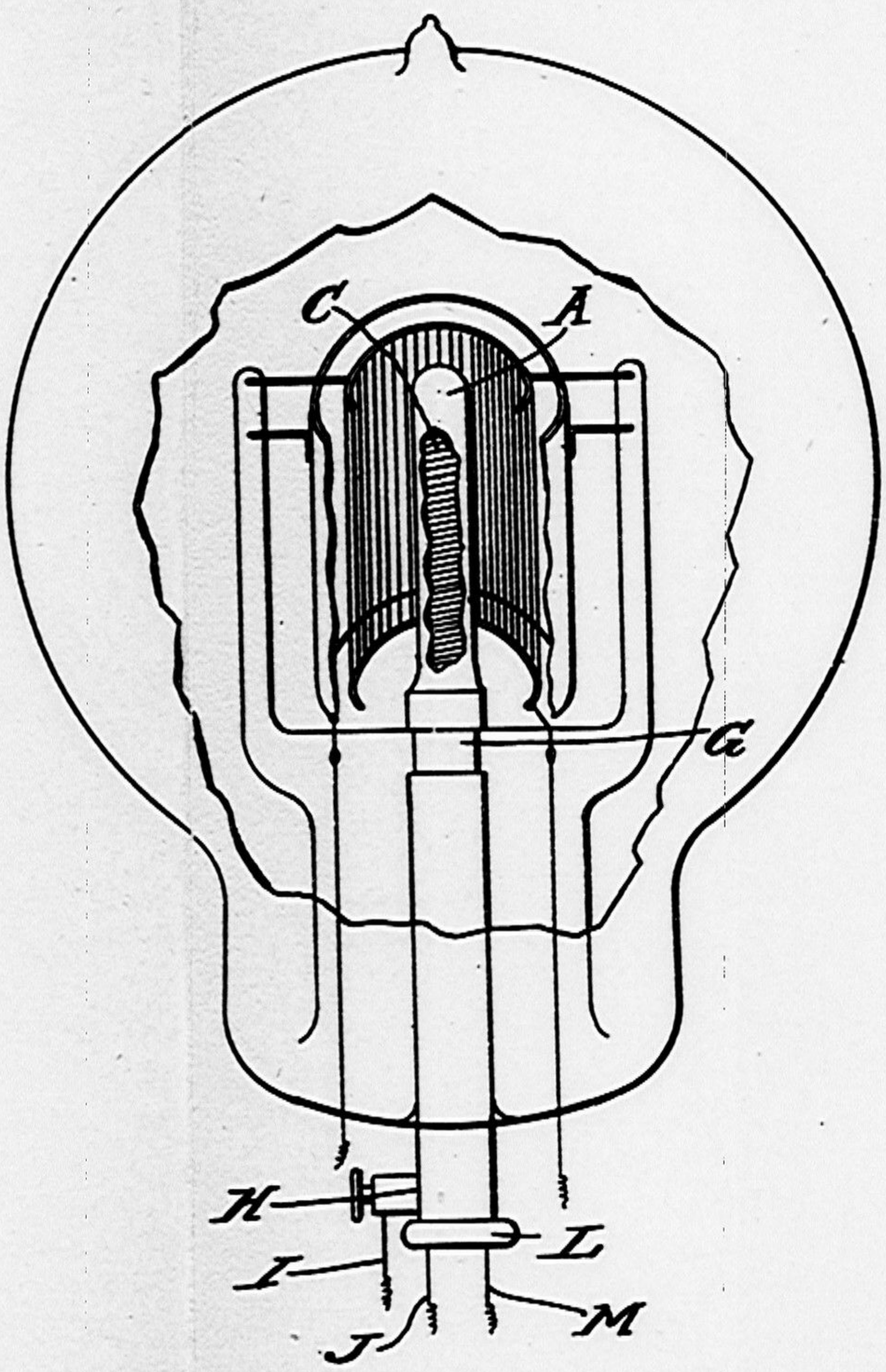


Fig: 1

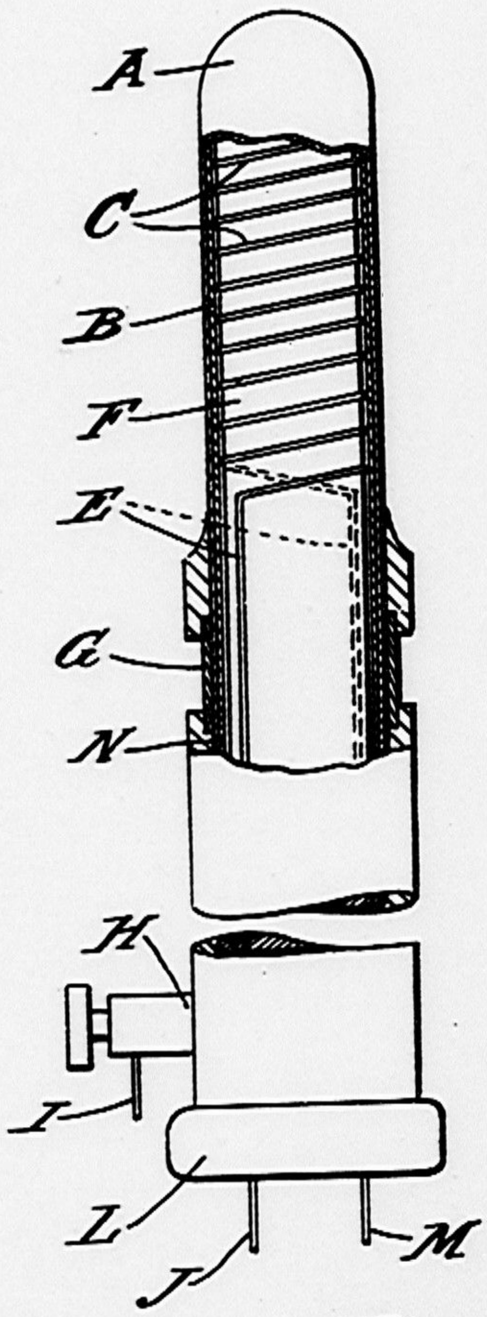


Fig: 2

INVENTOR.
Samuel S. Torrisi.
BY William J. Jackson
ATTORNEY.

UNITED STATES PATENT OFFICE.

SAMUEL S. TORRISI, OF PHILADELPHIA, PENNSYLVANIA.

CATHODE FOR AUDIONS.

1,368,584. Specification of Letters Patent. **Patented Feb. 15, 1921.**

Application filed July 10, 1918. Serial No. 244,150.

To all whom it may concern:

Be it known that I, Samuel S. Torrisi, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia, State of Pennsylvania, have invented new and useful Improvements in Cathodes for Audions, of which the following is a specification.

This invention relates to the improvement on the present type of filament cathodes used in audions, amplifiers and all other instruments where a filament is used as cathode for the emission of electrons.

A few recognized defects in the present type of filament cathodes consist of its small exposed surface and its duration of life, which although sometimes lasting a reasonable length of time, eventually must burn out, thus making the whole instrument useless.

The object of this invention is to eliminate the filament cathode, substituting for it a cathode which is constructed so as to contain in its inside a heating coil, heating the cathode walls; causing them to emit electrons, and which heating coil is renewable from the outside of the instrument. Another object of this invention is to provide a cathode which has a larger surface.

Figure 1, is a view in elevation, partly sectioned, illustrating the application of the cathode embodying features of the present invention to an audion, and

Fig. 2, is a similar view of the cathode detached.

In the accompanying drawings Fig. 2 represents an enlarged form of this cathode which is made of metal preferably nickel, cylindrical shape, airtight, with a thin cap, A, also of nickel which is platinum plated both inside and outside and covered on the outside walls with an oxid to facilitate and intensify electron discharges. The cap A is coated, internally and externally considered, upon the emitting portion only with platinum. That portion of cap A exposed to vacuum within a lamp proper is coated with oxid. Substantially midway of the length of the cathode is an annular recessed portion having welded thereto an annulus G of platinum. A standard type of audion is so fitted with respect to the said recessed portion of the cathode that an air tight space is present around that part of the cathode above the part G.

Running through the whole length of this tube is a rod of mica, porcelain or any other heat resisting composition F wound on its tip with the heating coil C with leads E running down this rod to the outside of the tube making two connections J and M.

The rod F has a covering of thin mica sheet B and N to prevent the wires of the heat coil from coming into contact with the inner wall of the cathode A. The threaded cap L serves to prevent the rod F from slipping out.

The cathode connection I is through the binding post, soldered at H.

In the drawing Fig. 1 represents the mode of adopting this tube to the audion; G being the lead in while J and M are the heat coil terminals. I is a connection for the tube acting as the cathode.

What I claim is:—

1. A cathode and a heat coil wound upon a removable rod inclosed in the cathode renewable for heating the cathode.

2. A rod of heat resisting material having wound on it a heat coil to heat an electron emitting cathode and a cathode for housing said coil.

3. A cathode having its outer end closed, a heat coil and a thin sheet of heat resisting insulator to prevent the heat coil touching the metal walls of the cathode.

4. A cathode of the character stated comprising an elongated tube-like cap one end of which is positively closed, a rod removably mounted in said cathode, a heat coil wound upon said rod and an annular member of platinum applied to said cathode below the emitting portion of said cathode.

In witness whereof, I hereunto subscribe my name this 9th day of July, A. D. 1918.

SAMUEL S. TORRISI.

Witnesses:
William J. Jackson,
Joseph Torrisi.

June 19, 1923. **1,459,400**

C. D. HOCKER

ELECTRON EMITTING CATHODE AND PROCESS OF MAKING THE SAME

Filed Nov. 17. 1916

Fig. 1.

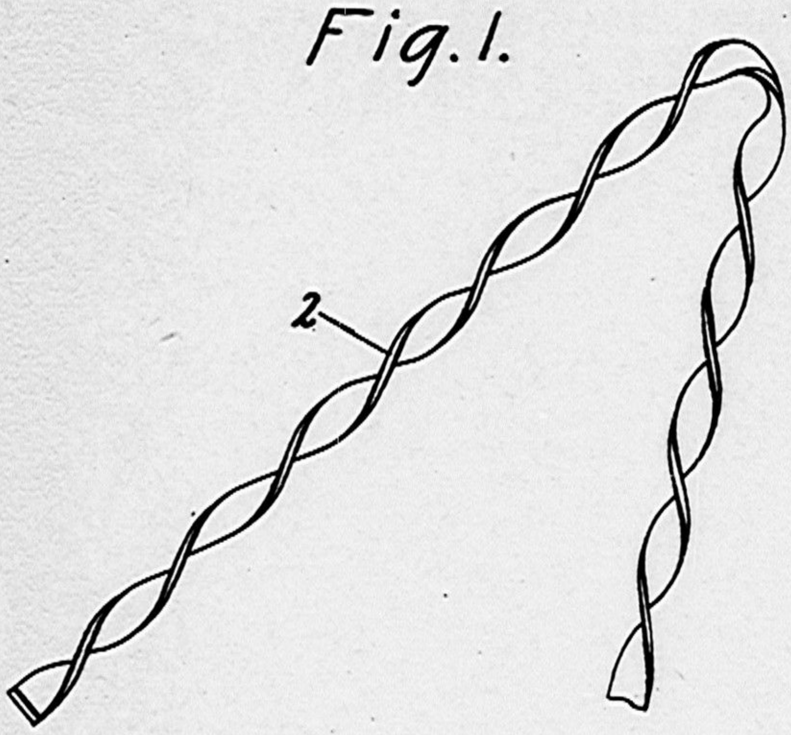
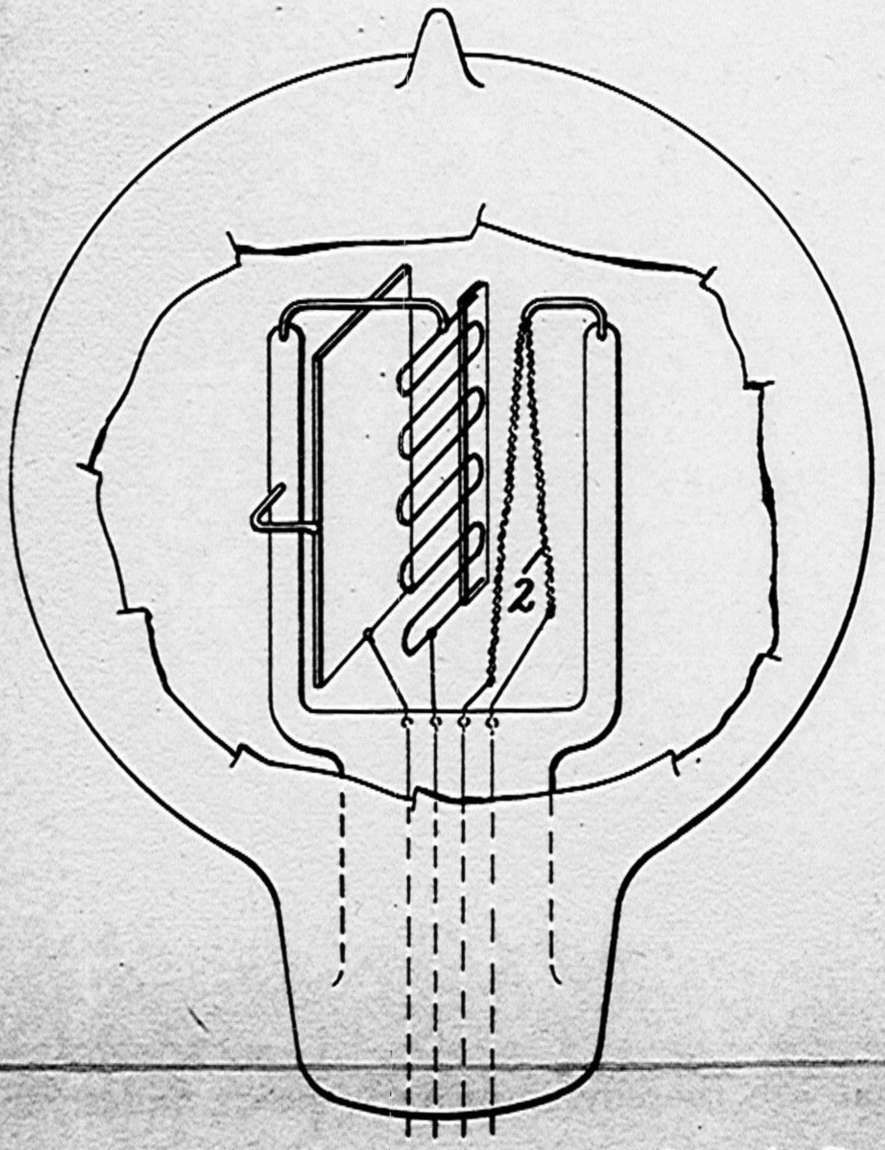


Fig. 2.



Inventor:
Carl D. Hocker
by S. T. Hannel. Att'y.

Patented June 19, 1923. **1,459,400**

UNITED STATES PATENT OFFICE.

CARL D. HOCKER, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRON-EMITTING CATHODE AND PROCESS OF MAKING THE SAME.

Application filed November 17, 1916. Serial No. 131,858.

To all whom it may concern:

Be it known that I, Carl D. Hocker, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Electron-Emitting Cathodes and Processes of Making the Same, of which the following is a full, clear, concise, and exact description.

This invention relates to electron emitting cathodes, and the process of making the same, and has for an object to improve the characteristics of such cathodes in any one or more of the following particulars:

A.—To make the thermionically active coating adhere more firmly to the electrode or filament by mechanically binding the active coating materials to the filament.

B.—To increase the electron emission at any given temperature.

C.—To lengthen the life of the filament at any given temperature.

This is accomplished by adding another substance such as a noble metal to the coating before it is applied. By noble metal is included compounds of a noble metal from which the noble metal may be produced by heating a compound thereof; for instance, gold, silver and platinum may be produced by heating gold oxide, silver oxide and ammonium chloro-platinate, respectively. Among the noble metals may be mentioned silver, gold and platinum, and the presence of one of these metals in the filament coating has been found to give the desired result. Whether the noble metal will serve to mechanically bind the coating to the filament, whether it increases the electron emission or length of life, or any combination of these, depends upon the noble metal used as well as upon the particular thermionically active substance or substances of which the coat is composed. The particular substance used in the coat, and the properties of the filament that are thereby improved will be later described.

The use of a material in the coating which serves to mechanically bind the coat to the filament has two distinct advantages: First, it makes it possible to apply any coating in an adherent form; second, it permits the application of coats composed of a mixture of substances in definite proportions—a definiteness which cannot be insured when these substances have to be alternately applied in layers as previous filaments have been made.

Fig. 1 of the drawing shows a twisted filament, electrode or cathode made according to the invention; and Fig. 2 shows an evacuated vessel having a filament such as shown in Fig. 1.

It is proposed to use a filament core of platinum or one of platinum alloyed with other metals of the platinum group, i. e., iridium, rhodium, palladium, osmium, ruthenium. Oxides or other compounds of the alkaline earth group, either singly or in combination, comprise a portion of the thermionically active coat to which is added one of the noble metals or a compound thereof, such as an oxide of platinum, gold or silver.

In making a cathode according to the invention, filament 2 of platinum which may be twisted as shown in Figs. 1 and 2, is suspended from spaced electrodes which are connected to a suitable source of electricity. The coating mixture is made into a fluid or plastic condition by mixing with a suitable fluid medium such as water. A trough filled with the coating mixture thus formed is moved longitudinally along the filament while the filament dips into the coating mixture. The coat is then dried or baked on the filament by heating the same to a suitable temperature. A convenient way of baking the coat is to pass an electric current through the filament. When the first coat is baked the filament is allowed to cool and a second coat is applied and baked. This process of applying a coat and baking the same is repeated four or five times, for example, or until a coat of suitable thickness has been provided. A filament thus treated is then baked for a suitable length of time at a temperature which depends upon the material used. Specific values of the temperatures and length of time for baking are given below. As to specific types of filaments and their characteristics, it has been found that the presence of platinum in the coat increases the length of life of a filament and mechanically binds the active coating to the filament. A filament having platinum in the coat may be made by using equal molecular parts of barium oxide and strontium oxide, to which mixture is added a molecular part of platinum equal to the sum of the molecular parts of the oxides. Metallic platinum is not used, but it is proposed to use a suitable compound thereof such as ammonium chloro-platinate $(NH_4)_2 PtCl_6$ which is easily converted to metallic platinum on ignition. These ingredients are mixed with water and applied as a paste to the wire being coated. Three to five coats should be applied to the filament which should be finally baked in air at a temperature of about 1,000 degrees centigrade for about two hours.

The life of the filament can be still further increased by adding calcium oxide to the coating mixture. For instance, equal molecular parts of barium oxide, strontium oxide and calcium oxide may be mixed with three molecular parts of platinum in the form of ammonium chloro-platinate. This filament is given the same treatment as the one described in the preceding paragraph. The subject matter of this paragraph is described and claimed in the application of Harris Serial No. 139,532, filed December 29, 1916, for electron emitting cathodes and process of manufacturing the same.

A filament having an electron emission which is higher at a given temperature than the filaments described above, may be provided by adding gold in the form of gold oxide to the coating material instead of adding platinum in the form of ammonium chloro-platinate. The table given below indicates the proportions of the various ingredients which have been found to give good results.

Gold in the coat.

(Molecular parts.)

BaO.	SrO.	CaO.	Au.
⅓	⅓	⅓	1
....	1	....	1

The filaments having gold in the coat must, after coating, be finally baked only a short time, for example, about five to ten minutes, and at a low temperature, for example, about 600 to 700 degrees centigrade.

Filaments having silver in the coat have an activity at a given temperature which is very much better than other known types of filaments. Such a filament will not stand to be run at high temperatures without burning out. However, they will supply all of the space current required of other types of filaments now in use without being operated at a temperature high enough to endanger their life. All of the filaments below described having silver in the coat appear to last indefinitely when run at the minimum filament current (i. e. lowest temperature) necessary to give the electron emission required of filaments now in use.

The following table gives the proportions of the various ingredients including silver which may be used in the coating mixture. The compound of silver used was the oxide Ag_2O.

Filaments with silver in the coat.

(Molecular parts.)

BaO.	SrO.	CaO.	Ag.
½	½	....	2
⅓	⅓	⅓	1
⅓	⅓	⅓	2
....	1	....	1
1	....	....	1

The filaments having silver in the coat must be baked only a few minutes, that is, about five to ten minutes, and at a low temperature, for instance, at 600 to 700 degrees centigrade. This is to fix the coating or to make it adhere to the filament core. Then this filament is mounted in a tube which is exhausted by any suitable means to produce a high vacuum. An electric current is passed through the filament to heat the same to a temperature sufficient to volatilize all or substantially all of the silver. The volatilized silver sublimes and forms a coating on the inside of the vacuum tube. The filament may then be removed from this tube and mounted in another tube, in which it is to be used as an electron source or the volatilization of the silver may take place in a tube of the form shown in Fig. 2, in which the filament is permanently mounted as the presence of the silver coating on the sides of the tube does not interfere with the operation of the tube as a thermionic device.

Reference is made throughout the specification to "platinum" filaments and to filaments having a "platinum" core, by which is meant a filament composed chiefly of platinum even though the filament core contains small amounts of other substances, such as iridium, which is found in commercial platinum, and the claims which recite "a filament containing platinum" or the like, are to be construed as meaning that the filament contains at least platinum, and not that the filament contains platinum to the exclusion of other metals or substances. This construction is to be given the word "containing" wherever used in the claims.

What is claimed is:

1. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing a metal of the alkaline earth group and a noble metal.

2. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing a metal of the alkaline earth group and a noble metal, and baking said coating.

3. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating con-

taining barium, strontium and a noble metal, and baking said coating.

4. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing a noble metal and a thermionically active metal, and baking said coating.

5. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing silver and a metal of the alkaline earth group, and baking said coating.

6. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing silver, barium and strontium, and baking said coating.

7. The process of manufacturing an electron emitting cathode which consists in applying to a filament containing platinum, a coating containing silver and a metal of the alkaline group, and baking said coating.

8. The process of manufacturing an electron emitting cathode which consists in applying to a filament containing platinum, a coating containing silver, barium and strontium.

9. The process of manufacturing an electron emitting cathode which consists in preparing a coating by mixing a substance containing a metal of the alkaline earth group with a substance containing a noble metal, applying said coating to an electric conductor, and baking said coating.

10. The process of manufacturing an electron emitting cathode which consists in preparing a coating by mixing a substance containing a metal of the alkaline earth group with a substance containing a noble metal, applying said coating to an electric conductor, baking said coating, applying another of said coatings, and in baking said coatings.

11. The process of manufacturing an electron emitting cathode which consists in coating an electric conductor with a coating comprising a fluid medium, an oxide of a noble metal and a substance containing a metal of the alkaline earth group, baking said coating, and in repeating the steps of coating and baking to provide a coat of a desired thickness.

12. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing a metal of the alkaline earth group and a noble metal, in baking said coating, and removing the noble metal from the coating.

13. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing a metal of the alkaline earth group and a volatilizable noble metal, and in baking said coating at a temperature sufficient to volatilize the noble metal in said coating.

14. The process of manufacturing an electron emitting cathode which consists in applying to an electric conductor a coating containing a metal of the alkaline earth group and a volatilizable noble metal, in initially baking said coating to fix the same on said conductor, and in finally heating said coating in vacuo to a temperature sufficient to volatilize the noble metal from said coating.

15. An electron emitting cathode comprising an electrode containing a noble metal, said electrode having a coating containing a different noble metal and a metal of the alkaline earth group.

16. An electron emitting cathode comprising an electrode containing a noble metal, said electrode having a coating containing an oxide of a different noble metal and metallic oxides of the alkaline earth group.

17. An electron emitting cathode comprising an electrode having a coating containing silver and a metal of the alkaline earth group.

18. An electron emitting cathode comprising a platinum electrode having a coating containing silver and a metal of the alkaline earth group.

19. An electron emitting cathode comprising an electrode containing silver, barium and strontium.

20. An electron-emitting cathode having a multi-layer coating, each of said layers containg a metal of the alkaline earth group and a noble metal.

21. The process of manufacturing an electron emitting filament which comprises coating a metallic core with an alkaline earth oxide, treating said filament with a volatilizable noble metal, and in removing said noble metal from said filament.

22. The process of manufacturing an electron emitting filament which comprises coating a metallic core with an alkaline earth oxide, treating said filament with a noble metal at a temperature below the volatilization point of said noble metal, and then heating said filament to a temperature above the volatilization point of said noble metal.

23. The process of manufacturing an electron emitting filament which comprises coating a metallic core with an alkaline earth oxide, treating said filament with silver at a temperature below the volatilization point of silver, and then heating said filament to a temperature above the volatilization point of silver.

In witness whereof, I hereunto subscribe my name this 16th day of November, A. D., 1916.

CARL D. HOCKER.

Patented July 6, 1926. **1,591,717**

UNITED STATES PATENT OFFICE.

JOHN WESLEY MARDEN, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO WESTINGHOUSE LAMP COMPANY, A PENNSYLVANIA CORPORATION.

ELECTRON EMISSION MATERIAL AND METHOD OF MANUFACTURE.

No Drawing. Application filed September 28, 1922. Serial No. 591,157.

This invention relates to electron-emission material and more particularly to that composed of alkaline-earths made conductive by the admixture therewith of finely-divided metallic material.

An object of my invention is the manufacture of electron-emission material in which the active electron-emitter is a refractory oxide, substantially non-conductive and having conductivity imparted thereto by the incorporation therewith of conductive material, for example, metallic powder.

Another object of my invention is the production of electron-emitting material consisting of alkaline-earths impregnated with metallic material to make them conduct electric current, cohere firmly in the desired form and adhere more firmly to a metallic core, if such is used, with less cracking off in use, whereby the life of such material may be increased.

A further object of my invention is the formation of filamentary material provided with a thicker coating of electron-emitting oxides than heretofore, without impairing the electron-emissivity of the material.

A still further object of my invention is the manufacture of composite wire consisting of metal impregnated with alkaline earths to make it emit electrons efficiently when heated and which may, if desired, be provided with a metal core.

Other objects and advantages of the invention will be disclosed from the following detailed description.

The alkaline earths, that is, the oxides of barium, strontium and calcium have been found to be excellent material for electron-emission purposes when heated to proper temperatures. Barium oxide has been found to have the highest electron-emissivity of the three but is usually mixed with strontium oxide for mechanical reasons, that is, the mixture of the two oxides is found to adhere to filamentary material better than barium oxide alone. A common method of making use of the electron-emitting properties of said oxides is to coat platinum-iridium ribbon with a mixture of the oxides of barium and strontium and introduce the same into an electron device as the hot cathode thereof.

It has been found that only a very thin coating can be applied to a ribbon or filament for this purpose, because of the non-conducting properties of such oxides. When used in such electron device, the small amount the oxide on the filament gradually vaporizes and the filament finally develops bare spots or portions from which the oxide has been completely vaporized, thus causing a diminution of the electron-emissivity of such coated filament as well as other undesirable consequences. If the oxide is applied thicker than usually, the electron-emissivity of the filament is reduced because of the insulating properties of the oxide.

According to my invention, I obviate the above noted difficulties by mixing a finely divided conductive material with the oxide material.

Another embodiment of my invention involves the making of the filament entirely of electron-emitting oxides impregnated or intimately mixed with conductive material. Such conductive material is preferably one of the refractory metals, such as platinum, tantalum or the like, but other metals are contemplated for use in this connection, for example, chromium, iron, nickel and the like.

Essentially, my invention comprises intimately mixing and incorporating together powdered alkaline earths, for example, a mixture of the oxides of barium and strontium or the carbonates thereof, which may readily be decomposed to form the oxides, with finely divided or powdered platinum, tantalum or the like. Instead of using platinum, a platinum compound, such as platinic chloride, mixed with reducing agent, such as paste, may be used.

The mixture may then be made into the form of a suspension and applied to any desired filamentary material by any suitable known method; for example, it may be mixed with a suitable binder, such as nitrocellulose dissolved in amyl-acetate, applied to filamentary material, such as tantalum or platinum-iridium ribbon, by passing the same through said suspension, and baking the same onto the filament in the same way, as is described, for example, in the copending application of Marden and Rentschler, Serial No. 489,108, filed August 1, 1921, composite bodies and method of producing the same and assigned to the Westinghouse Lamp Company.

The mixture of oxides and metal may be made up as an aqueous suspension, if desired, and the platinum-iridium or other filament uniformly coated therewith and heated to cause it to bake firmly thereto. Such procedure is similar to the method described and claimed in the copending application of MacRae and Richardson, Serial No. 566,847, filed June 8, 1922, getters and the application thereof and assigned to the Westinghouse Lamp Company.

The method described and claimed in the copending application of Duncan MacRae, Serial No. 587,270, filed September 11, 1922, electron emitting devices and method of making and assigned to the Westinghouse Lamp Company, may be used for coating filamentary material with a mixture of alkaline-earth carbonates and powdered metal, such carbonate being eventually reduced to oxide according to the method disclosed in said application.

Instead of coating filamentary material with such mixture, the same may be formed into a thick paste and squirted into a filament in a manner similar to that in which squirted tungsten filaments were formerly made. Instead of squirting the filament, platinum or tantalum powder, for example, could be mixed with the desired amount of alkaline earths, pressed into a slug and treated in accordance with the method now commonly utilized for treating tungsten and molybdenum; that is, the slug could be swaged or rolled down by suitable known processes and finally drawn to wire of the desired size, by which method there would be obtained an oxide-impregnated filament having an electron-emissivity corresponding with that of the alkaline-earths employed.

The following description is given to illustrate more clearly how my invention may be practiced, but it is to be understood that the proportions given are merely suggestive and I do not intend to be bound thereby. Filamentary material, for example, platinum-iridium ribbon, may be thoroughly cleaned, as by passing it through an electric tube furnace, according to the method described in the aforementioned copending application of Duncan MacRae. A suspension of preferably about equal parts of the oxides of barium and strontium, with any desired proportion of metal powder, for example, platinum powder, tantalum powder or the like, may be prepared.

The vehicle used for such a suspension is preferably water, but an organic binder such as nitro-cellulose dissolved in amyl-acetate may be used if desired. The proportion of the metal powder to the alkaline earths depends on the thickness of coating to be applied to the filamentary material and may vary from a small amount, for example, form 5 to 10% to a relatively large proportion, for example, from 80 to 90%. The thicker the coating to be applied to the filamentary material, the larger the proportion of metal powder should be in the mixture.

The mixture may be ground up in a mortar with a pestle and enough water gradually added to form a homogeneous suspension having the consistency of a thin paste. Such a suspension may be poured into a gettering cup or the like and the filamentary material passed over or around the gettering wheel thereof to coat the same uniformly with the suspension, after which the filament may be passed through an electric furnace where the suspension is baked thereon, similar to the method described and claimed in the aforementioned application of Duncan MacRae for applying alkaline-earth carbonates to a filament.

One or more coatings of the suspension may be applied to the filamentary material, depending on the thickness of the coating desired thereon. Filamentary material, coated as aforedescribed, permits the use of a thicker coating than if no metal were mixed with electron-emitting oxides, because the metal powder in the coating serves as a conducting medium to bring the electrons to the surface, the electron-emitting oxide serving merely as the final gate-way by means of which the electrons are discharged. Such coated material has a longer life than previously prepared oxide-coated filaments, because of the thicker coating of the oxide thereon, whereby the same may be heated for a longer time before all the oxide is completely vaporized from any portion of the surface of the original filament or metallic core of the coated filament. Such a part-metallic coating will adhere more firmly to a wire than one containing no free metal.

Another embodiment of my invention comprises utilizing such suspension as is heretofore described for making squirted filaments. Of course, in this case, it is necessary to use less of the vehicle, so that a suspension of a consistency of a very thick paste is formed. If water is used for the vehicle, it is preferable to use some binder, such as glue, but any suitable vehicle may be used so that a squirted filament of sufficient strength for the necessary handling is prepared.

Platinum or tantalum powder are preferably mixed with a relatively small proportion of the oxides of barium and strontium, or the oxide of barium only, so that the squirted filament, when sintered, will have substantially the physical characteristics of the metals themselves. Instead of squirting a filament from such a mixture, platinum or tantalum powder may be mixed with a small proportion of one or more of the alkaline earths, pressed into a slug and sintered, swaged or rolled and drawn to wire of the desired size, according to well known methods now employed in the manufacture of metals of the tungsten class into filamentary form.

It will readily be appreciated that, according to my invention, I have devised a way for activating filamentary material with alkaline earths in a manner involving the use of said earths in greater thicknesses than have heretofore been feasible, whereby greater efficiency and longer life are obtained.

Although I have described what, at present, I consider to be the preferred embodiments of my inventive idea, it is to be understood that modifications will suggest themselves to those skilled in the art within the spirit and scope of the appended claims and that such modifications are to be considered as embodying my invention.

What is claimed is:

1. Electron-emission material comprising an alkaline earth uniformly distributed through tantalum.

2. Electron-emission material in coherent form comprising alkaline earths uniformly distributed through tantalum.

3. Filamentary material for electron-emission purposes comprising a mixture of the oxides of barium and strontium made conductive by having powdered tantalum metal uniformly distributed therethrough and incorporated therewith.

4. Electron-emission material comprising a conductive core, coated with a non-conductive oxide impregnated with tantalum.

5. Electron-emission material comprising a conductive filament having a coating thereon of alkaline earths mixed with tantalum.

6. Electron-emission material comprising a filamentary metal core coated with a mixture of alkaline earths incorporated with finely divided tantalum metal.

7. Filamentary material for electron-emission purposes comprising a refractory metal wire coated with the oxides of barium and strontium having finely-divided tantalum metal uniformly distributed therethrough.

8. The method of making electron-emission material comprising incorporating together alkaline earths and finely divided tantalum metal and working the same into the desired coherent form.

9. The method of making filamentary material for electron-emission purposes, comprising uniformly mixing together finely divided tantalum and a small proportion of at least one of the alkaline earths and working said material into coherent filamentary form.

10. The method of manufacturing filamentary material for electron-emission purposes comprising preparing a suspension of the oxides of barium and strontium and finely divided tantalum metal uniformly distributed therethrough, passing a refractory metal filament through said suspension to coat the same therewith and heating said filament to cause a firm adherence of the mixture thereto.

11. The method of manufacturing filamentary material for electron-emission purposes, comprising coating tantalum wire with a uniform mixture of metallic tantalum and alkaline earth material.

In testimony whereof, I have hereunto subscribed my name this 27th day of Sept., 1922.

JOHN WESLEY MARDEN.

No. 761,380. PATENTED MAY 31, 1904.

J. A. HEANY.

ELECTRIC ARC LIGHTING.

APPLICATION FILED FEB. 4, 1904.

NO MODEL.

Fig. 1.

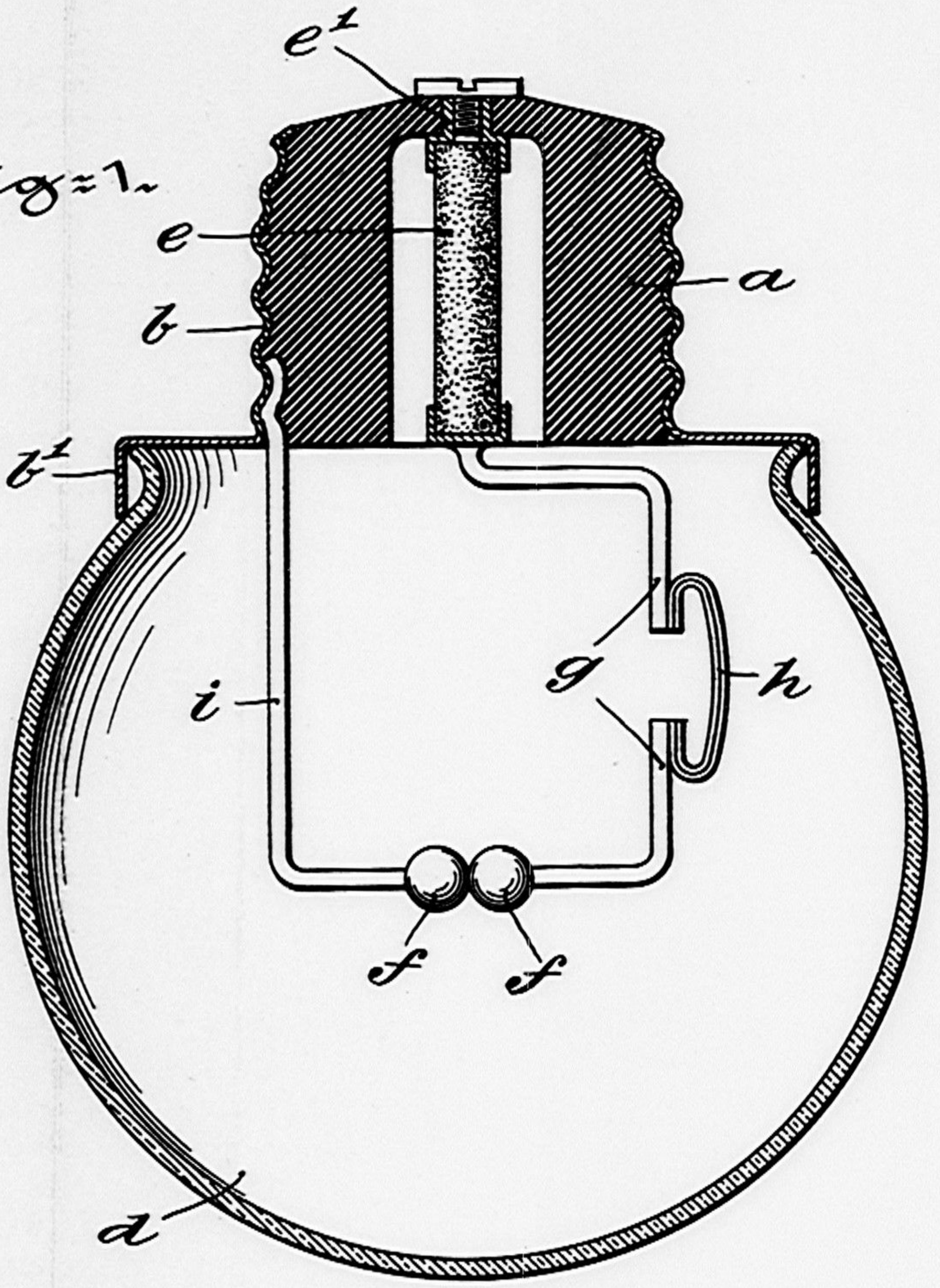
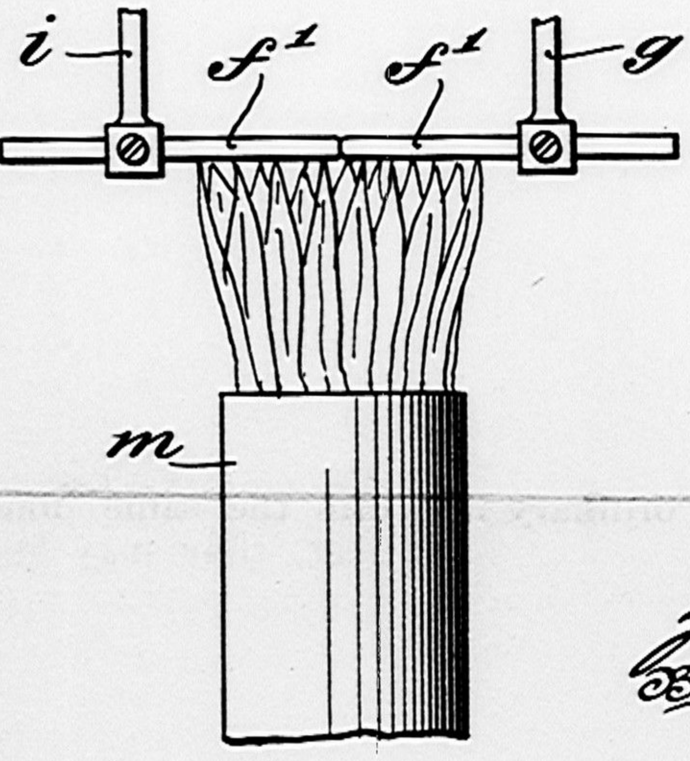


Fig. 2.



Witnesses:
Jas. C. Wobensmith
Wilhelm Vogt

Inventor:
John A. Heany
By J. Walter Douglass
Attorney.

No. 761,380. **Patented May 31, 1904.**

UNITED STATES PATENT OFFICE.

JOHN ALLEN HEANY, OF YORK, PENNSYLVANIA, ASSIGNOR TO THE TETER-HEANY DEVELOPING COMPANY, OF CHARLESTON, WEST VIRGINIA, A CORPORATION OF WEST VIRGINIA.

ELECTRIC-ARC LIGHTING.

SPECIFICATION forming part of Letters Patent No. 761,380, dated May 31, 1904.

Original application filed December 4, 1903, Serial No. 183,703. Divided and this application filed February 4, 1904. Serial No. 191,946. (No model.)

To all whom it may concern:

Be it known that I, John Allen Heany, a citizen of the United States, residing at York, in the county of York and State of Pennsylvania, have invented certain new and useful Improvements in Electric-Arc Lighting, of which the following is a specification.

My invention has relation to electric lighting in which an arc-lamp is provided with electrodes formed of materials which normally are non-arcing, and in such general connection it relates to means whereby, in such a lamp, the electrodes may be brought to and maintained in condition for arcing.

The present application is a division of an application for patent filed by me under date of December 4, A. D. 1903, and under the Serial No. 183,703.

To those skilled in the art it is well known that certain substances—such as metallic oxids, metallic salts, &c.—are normally non-arcing when used as the electrodes or terminals for the current. While such substances with currents of high tension may, perhaps, when brought close together discharge the current in disrupted arcs or sparks, yet such disrupted arcing or sparking is not useful in the production of a light such as is emitted from the ordinary arc-lamp having carbon electrodes. I have discovered how these normally non-arcing materials may be brought to a condition wherein an arc of appreciable size and continuity can be formed and maintained between electrodes composed of these materials, so that a light of greater luminosity and sharpness can be obtained at much less amperage than the amperage required in either the ordinary incandescent or arc lamp.

The principal object of my present invention is to provide, as an improvement in electric lighting, for the production and maintenance of an arc upon a normally non-arcing electrode with a current of relatively low amperage.

The nature and scope of my invention will be more fully understood from the following description, taken in connection with the accompanying drawings, forming part hereof, in which—

Figure 1 is a sectional view illustrating diagrammatically an arc-lamp embodying main features of my invention, and Fig. 2 is a front elevational view of a modified form of electrode.

Referring to Fig. 1 of the drawings, *a* represents a hollow plug, of di-eletric material, surrounded by a screw-cap *b*, of metal, having a downwardly-projecting flange *b'*, into which a globe *d* is fitted. Within the hollow of the plug *a* is secured a carbon or graphite resistance *e*, connected by a metallic plug *e'* with one terminal of the circuit. The screw-cap *b* is connected with the other terminal of the circuit. The electrodes *f f* of the lamp are respectively connected with the resistance *e* by a divided wire *g*, the ends of which are connected by a thermostat *h* and a continuous wire *i*, depending from the screw-cap *b*. So far as described the parts and their arrangement are comparatively unimportant and embody merely one of many forms of lamps in which my present invention may be embodied or carried out. In Fig. 1 the electrodes *f f* are sperical, or substantially so, in shape. In Fig. 2 the electrodes *f' f'* are pencils of the materials. One or both of each of the electrodes *f f* or *f' f'* is or are formed of a material non-arcing at ordinary temperatures—such, for instance, as the metallic oxids or salts of metals, as cerium, thorium, calcium, magnesium, yttrium, &c. Where these oxids or salts are sufficiently coherent to be molded or formed into the shape required and to maintain the same under the influence of high heat, they may be used alone; otherwise a binding agent—such as a borate, carbonate, phosphate, sulfate, or even boracic acid—should be used. When the electrodes are formed of such non-arcing materials, no appreciable continuous or luminous arc will be produced at ordinary temperatures of the electrodes with a current of even a high or relatively high tension. When, however, the electrodes of non-arcing materials are first heated to redness or substantially to incandescence, an arc of appreciable size and continuity will be formed and maintained between the electrodes when the tension of the current is relatively low—say about one hundred and ten volts—and the amperage much less than is required in the ordinary incandescent or filament lamp—say from one-tenth to one-half of an ampere or from eleven to fifty-five Watts. Not only is such a continuous arc formed or maintained, but the luminosity and sharpness of the light are materially greater than that which the incandescent lamp gives under greater consumption of current. One means of initially heating the electrodes $f\,f$ or $f'\,f'$ may be a spirit-lamp or Bunsen burner m, as illustrated in Fig. 2. Another which is not extraneous to the lamp, and therefore preferable, is to incorporate in the electrodes a highly-conductive material—such, for instance, as platinum, gold, iridium, &c., which, as is well known, are good conductors within ordinary temperatures. The effect of combining or incorporating such a good conductor with the non-arcing material or materials is to render such material or materials a partial conductor or conductor of high resistance. When the electrodes $f\,f$ or $f'\,f'$ touch, as illustrated in the drawings, the passage of the current through the electrodes $f\,f$ and $f'\,f'$ of high resistance serves almost instantaneously to heat the electrodes to redness or incandescence. By including a resistance e, of graphite or similar material, in the circuit the flow of current to the electrodes will be regulated inversely to the distance the electrodes are separated from each other to form the arc. The inclusion of a thermostat h or equivalent arc-adjusting means in the circuit renders the regulation of the size of the arc automatic.

Having thus described the nature and object of my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The improvement in electric-arc lighting, which consists in first heating the electrodes or terminals of normally non-arcing material to arcing temperature, and then establishing and maintaining an arc between them.

2. The improvement in electric-arc lighting, which consists in first heating by a small current the electrodes or terminals of normally non-arcing material to arcing temperature, and then establishing and maintaining an arc between them.

3. The improvement in electric-arc lighting, which consists in first heating the electrodes or terminals of normally non-arcing material to arcing temperature, and then establishing and maintaining an arc between them by a current of one ampere or less.

In testimony whereof I have hereunto set my signature in the presence of two subscribing witnesses.

JOHN ALLEN HEANY.

Witnesses:
J. WALTER DOUGLASS,
THOMAS M. SMITH.

R. A. FESSENDEN.
ELECTRIC SIGNALING.
APPLICATION FILED FEB. 8, 1907.

915,280. Patented Mar. 16, 1909.

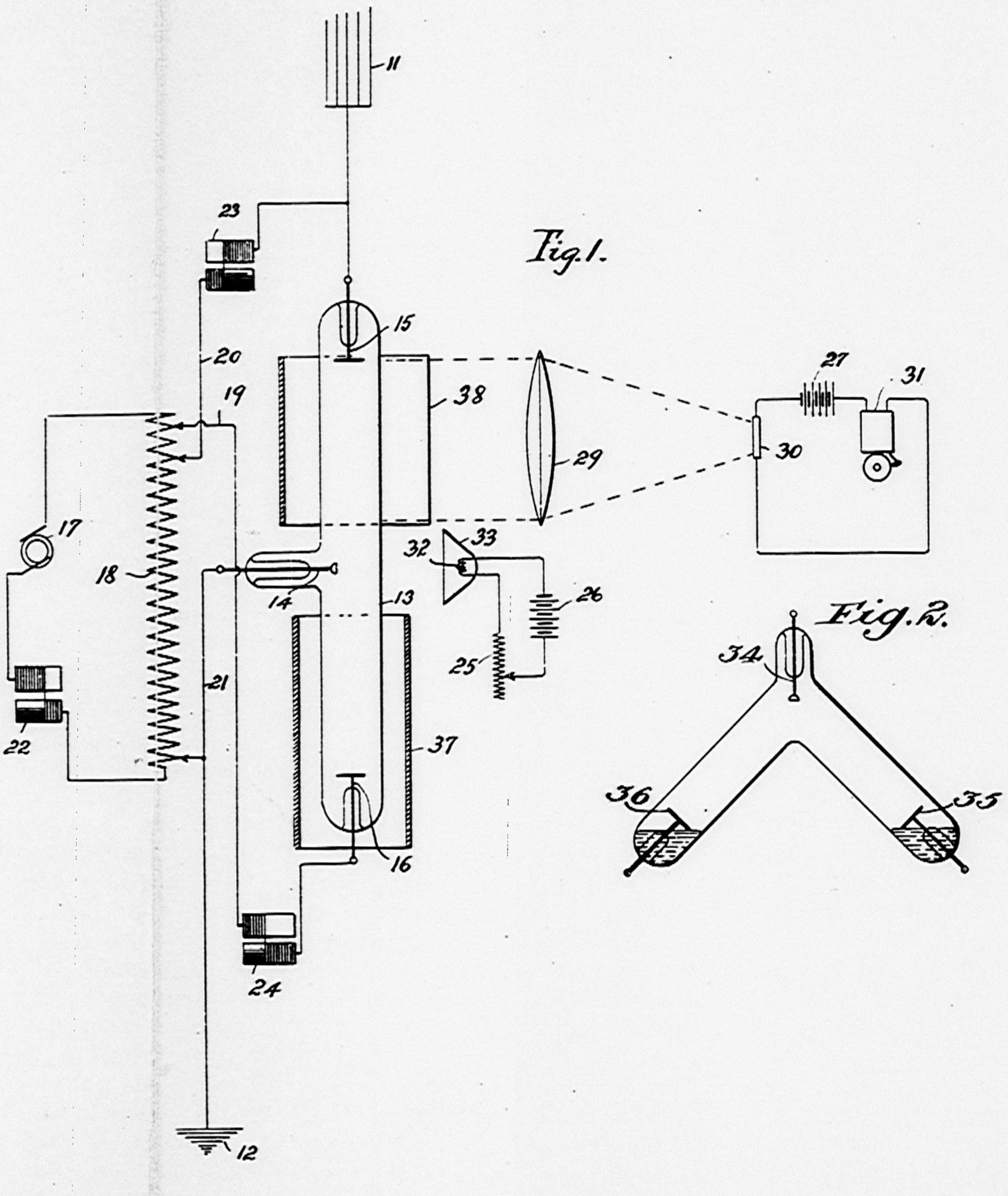


Fig. 1.

Fig. 2.

Witnesses
F. P. Mansbendel
Jessie E. Bent

Inventor
Reginald A. Fessenden.

UNITED STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTRIC SIGNALING.

No. 915,280. Specification of Letters Patent. Patented March 16, 1909.

Application filed February 8, 1907. Serial No. 356,383.

To all whom it may concern:

Be it known that I, Reginald A. Fessenden, a citizen of the United States, and a resident of Washington, in the District of Columbia, have invented certain new and useful Improvements in Electric Signaling, of which the following is a specification.

My invention relates to the art of electric signaling, and particularly to receivers for wireless telegraphy, its primary object being to provide a more reliable and sensitive means for receiving electric impulses, especially electro-magnetic waves, and producing signals thereby.

In the accompanying drawing Figure 1 is a diagram in partial section showing apparatus for carrying out my invention, and Fig. 2 shows in section a modified form of the receiver tube.

Vacuum tubes heretofore used as receivers for wireless telegraphy have not been found sufficiently sensitive and positive in their action, and especially for feeble impulses. I have experimentally discovered that the defects may be overcome as by using an improved differential vacuum tube containing gases, especially those of the helium type; and also by using differentially acting circuits. The efficiency is further improved by an essential arrangement of the parts one form of which is hereinafter specified.

In Fig. 1 the antenna 11 may be grounded as at 12, or not, and may be connected to the conductor 19 in other modifications. It is preferably tuned by any of the means well known in this art and may be used either with a secondary receiving circuit or without it as here shown. Connected with the antenna is a so-called vacuum tube 13, which may be of any desired shape, and may contain any suitable gas such as hydrogen, nitrogen, helium, argon, neon, etc., the ones named of the helium group having been found especially advantageous. The tube is provided with terminals 14, 15, 16, of which intermediate terminal 14 is preferably made extremely small and composed of iridium. I provide a source of voltage 17, which may be either a continuous current source, or an alternating current source, and is here preferably shown as a high frequency alternator, having preferably a frequency approximately the same as the frequency of impulses to be received. It is connected with a potentiometer 18 and may have a variable inductance or resistance 22 also in circuit. In this device one winding cylinder is metallic so as to short-circuit any number of turns of the wire desired. It will be understood that the outer ends of the coils on both cylinders are directly connected to the leads, and while on the insulating cylinder the whole length of wire is traversed, the metallic cylinder directly connects the initial point with the last turn of wire wound thereon. The conductors 19, 20 and 21 make adjustable contact with the potentiometer, and may contain variable resistances or inductances 23, 24 as shown. The terminals of the tube 13 may be heated by any suitable means as for example 14 is shown heated by coil 32 excited by battery 26 and having in circuit the variable resistance or inductance 25, the heat being projected by a reflector 33. A screen 37 may envelop the terminal 16 and a reflector 38 around the upper end of the tube is preferably used in order to direct the radiation through a lens 29, whence it impinges on selenium cell or bolometer 30 to thereby operate the indicating mechanism such as the bell 31 having battery 27 in circuit. Otherwise the signals caused by radiation from the upper end of the cell 13 may be read directly, or of course the bell may be replaced by a galvanometer.

In operation the potential between electrodes 14 and 15 is so arranged by means of the potentiometer that no current will pass between these terminals or only a slight and comparatively non-luminous one, while the greater current passes between 16 and 14. The potentials here are so adjusted that when electro-magnetic waves strike the antenna 11, the steady balance of current is disturbed in the differential vacuum tube 13, and the luminous column is caused to pass, either intermittently or steadily between terminals 14 and 15, which will effect a signal as above described.

In the construction of parts I prefer to make the terminals 15 and 16 of such material as iridium or aluminum and they may be covered with an oxid of calcium or its equivalents barium or strontium.

In Fig. 2 I have shown a different form of the tube, made in a **Y** shape, and the terminals may consist of mercury with central metallic projection as 35 or 36. In this case the mercury may contain a small percentage of metallic calcium or its equivalents or potassium or sodium with advantage.

The above described apparatus has been

found to act as a very reliable and steady receiver, it being a great advantage, among other things, to have the discharge diverted to an entirely new terminal and directly cause a signal by its incidental effects rather than by changes in the current being discharged passing through a detecting instrument.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent, is the following:

1. A receiver for electro-magnetic waves comprising an exhausted tube containing gas of the helium group.

2. A receiver for electro-magnetic waves comprising a discharge tube with several paths of discharge acting differentially and means for shifting the path of discharge therein by the waves received.

3. A receiver for electric signaling comprising a differentially acting discharge tube with several terminals, and connected differential governing circuits adapted to have their balance changed to shift the discharge path by the passage of signal impulses.

4. A receiver for wireless telegraphy comprising a discharge tube with several discharge paths therethrough, means operated by electro-magnetic waves to shift the path of discharge, and means independent of the tube circuit for effecting a signal by such shifting of the discharge path.

5. A receiver for wireless telegraphy comprising a discharge tube and means for exciting it; connected differential circuits adapted to have their balance disturbed by the passage of electro-magnetic waves to shift the path of discharge in the tube, and means to observe such shifting of discharge.

6. The combination with a current source and discharge tube having a central terminal and two legs each provided with a terminal, of means actuated by electro-magnetic waves to shift the discharge from one leg to the other, and indicating means operated by said shifting of the discharge.

7. A receiver for electric signaling comprising an electric discharge tube, means to annul or balance off the effective discharge in a path therein, and means operated by the received impulses to disturb the balance and restore said discharge to produce a signal.

8. A receiver for electric signals comprising a discharge tube with several alternative paths of discharge, and means, comprising a receiving circuit operatively connected to a terminal of the discharge tube for shifting the path of the discharge therein on receipt of the transmitted impulses.

9. A receiver for electric impulses comprising a discharge tube with several alternative paths of discharge and means comprising a receiving circuit operatively connected to a terminal of the discharge tube for altering the normal potentials between the terminals and so causing the path of the discharge therein to be shifted on receipt of transmitted impulses.

Signed at Brant Rock in the county of Plymouth and State of Massachusetts this 6th day of February, A. D. 1907.

REGINALD A. FESSENDEN.

Witnesses:
Jessie E. Bent,
Odeleine Dolever.

E. FRIEDERICH.

INCLOSED ARC LAMP AND METHOD OF STARTING THE SAME.

APPLICATION FILED JAN. 28, 1916. RENEWED DEC. 7, 1921.

1,422,553.

Patented July 11, 1922.

2 SHEETS—SHEET 1.

Fig. 1.

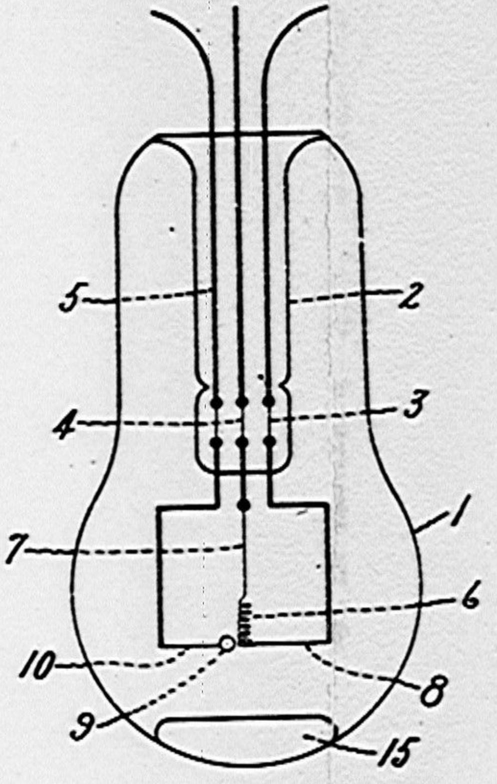


Fig. 2.

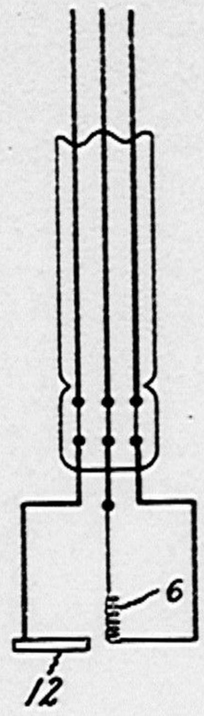


Fig. 3.

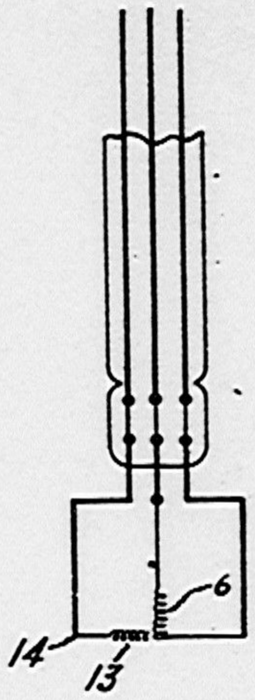


Fig. 4.

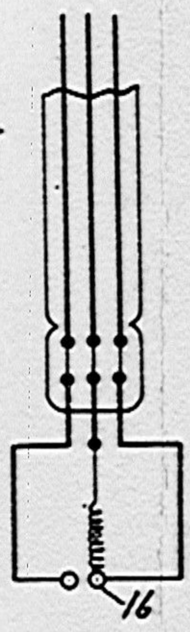


Fig. 5.

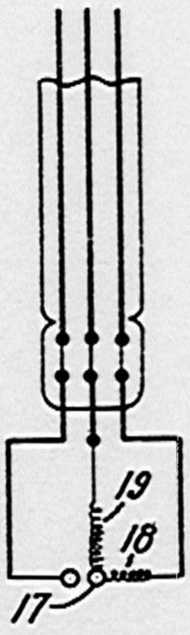


Fig. 6.

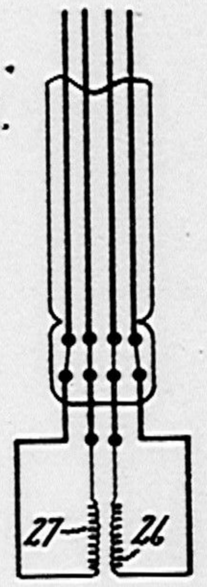


Fig. 7.

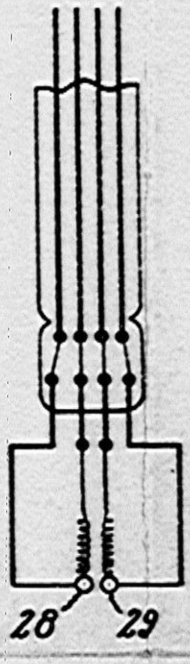


Fig. 8.

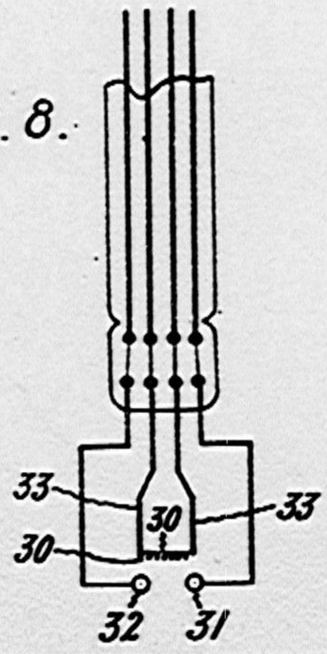
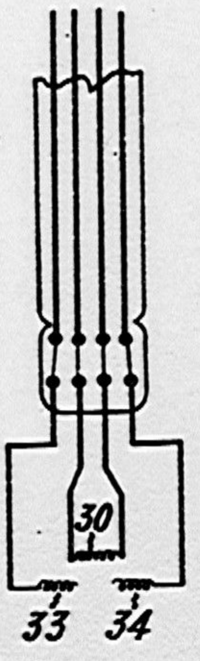


Fig. 9.



Inventor:
Ernst Friederich,
by
His Attorney.

39

E. FRIEDERICH.

INCLOSED ARC LAMP AND METHOD OF STARTING THE SAME.

APPLICATION FILED JAN. 28, 1916. RENEWED DEC. 7, 1921.

1,422,553. **Patented July 11, 1922.**

2 SHEETS—SHEET 2.

Fig. 10.

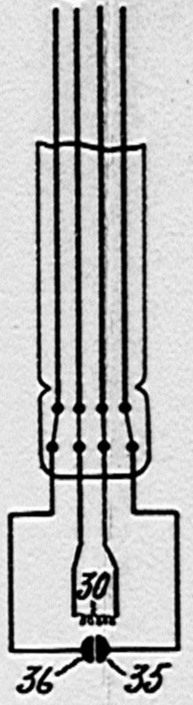


Fig. 11

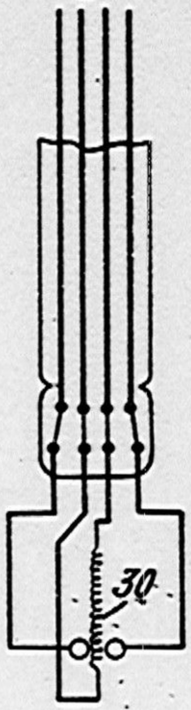


Fig. 12.

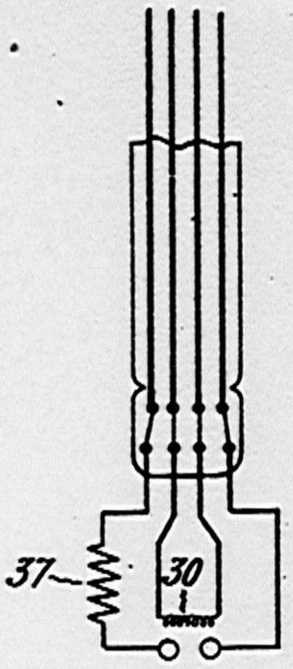


Fig. 13.

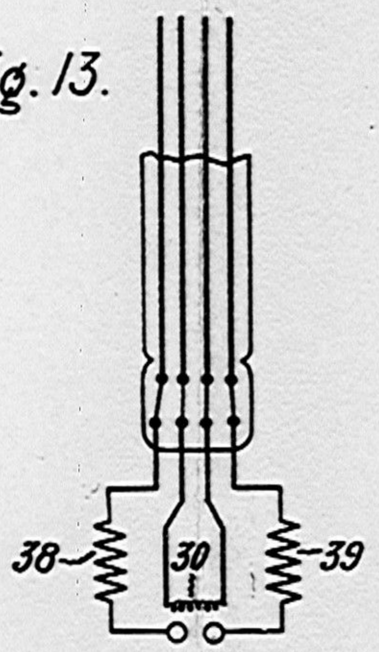


Fig. 14.

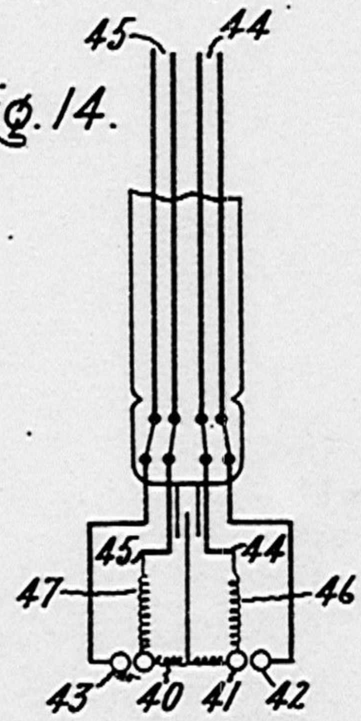


Fig. 15.

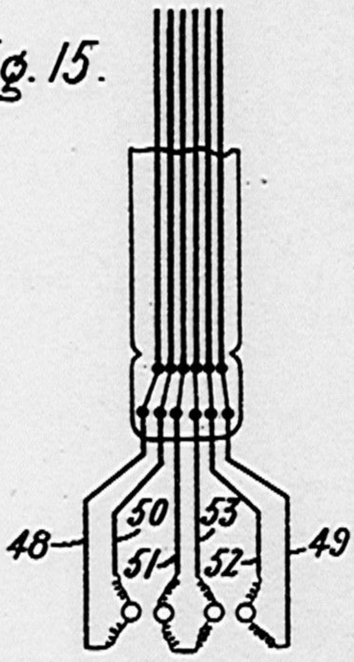


Fig. 16.

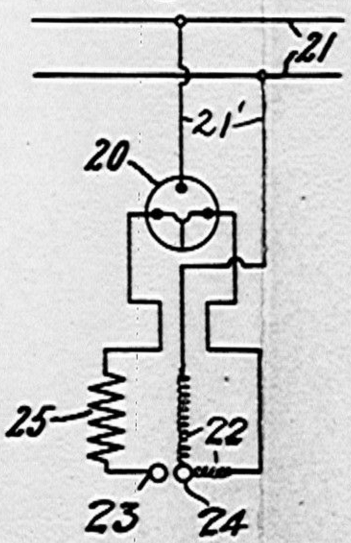


Fig. 17.

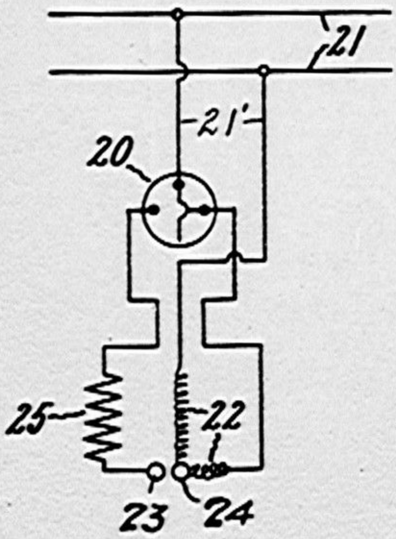


Fig. 18.

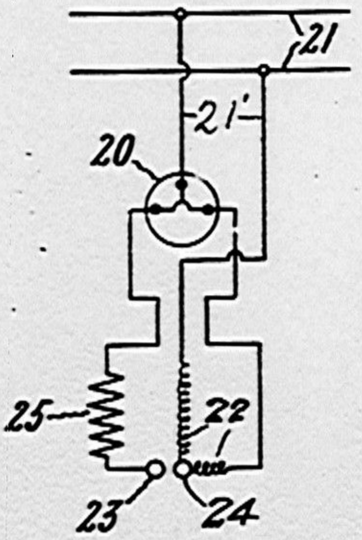
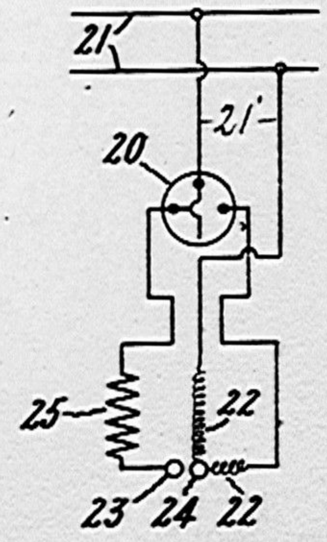


Fig. 19.



Inventor:
Ernst Friederich,
by
His Attorney.

UNITED STATES PATENT OFFICE.

ERNST FRIEDERICH, OF BERLIN, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

INCLOSED-ARC LAMP AND METHOD OF STARTING THE SAME.

1,422,553. Specification of Letters Patent. **Patented July 11, 1922.**

Original application filed October 13, 1914, Serial No. 866,438. Divided and this application filed January 28, 1916, Serial No. 74,935. Renewed December 7, 1921. Serial No. 520,719.

To all whom it may concern:

Be it known that I, Ernst Friederich, a subject of the King of Prussia, residing at Berlin, Germany, have invented certain new and useful Improvements in Inclosed-Arc Lamps and Methods of Starting the Same, of which the following is a specification.

This application is a division of my prior application, Serial No. 866,438, filed October 13, 1914.

The present invention comprises a lamp in which an arc is operated in an inclosed envelope between electrodes of refractory material, such, for example, as tungsten, in an indifferent atmosphere, the electrodes being proportioned to be heated to incandescence and remaining substantially intact or unconsumed when supporting an arc discharge.

It is one of the features of my invention to operate the arc in a vapor which will render the arc luminous, for example, mercury vapor, at relatively considerable pressure, preferably approximating atmospheric pressure.

Another feature of my invention comprises a lamp in which the series resistance required for steadying the arc is also operated at incandescence in the enclosing envelope and contributes light, thereby still further increasing the efficiency of the lamp and also improving the color of the light.

Other features of my invention comprise various means for heating one or more of the electrodes preliminary to and for the purpose of starting the arc.

The above and various other aspects of my invention are pointed out in the appended claims and will be better understood from the following description taken in connection with the accompanying drawings, of which Fig. 1 shows somewhat diagrammatically a simple form of direct current arc lamp embodying my invention; Figs. 2 to 7 are modifications; Figs. 8 to 11 illustrate a lamp in which a heated electrode distinct from the main electrodes is used to start the arc; Figs. 12 and 13 also show lamps in which the steadying resistance is used as a light source; Figs. 14 and 15 illustrate particular arrangements for operating a plurality of arcs in the same envelope, and Figs. 16 to 19 illustrate diagrammatically circuit connections for starting the lamp.

As shown in Fig. 1, the lamp consists of an enclosing globe 1 provided as usual with a stem 2 into which are sealed leading-in conductors 3, 4 and 5. The electrodes in the simplest type of lamp shown in Figs. 1 to 7, inclusive, include an electrode 6 consisting of tungsten, or other suitable refractory material, preferably closely coiled to reduce the cooling effect of the gas, and having its terminals 7, 8 joined in turn to leading-in wires 3, 4. Heating current is supplied thereby to initially heat the electrode 6. This heating current may be furnished by a separate source of energy of suitable voltage, or by the main source of energy for operating the lamp, in which case the coil 6 is preferably connected in series with a suitable external or internal resistance, as will be hereinafter explained in connection with some of the other figures.

The cooperating electrode 9 may consist either of a small metallic globule attached mechanically or by welding to a conductor 10 of smaller cross-section, or, as shown, in Fig. 2, may consist of a small rod 12 of metal, or, as shown in Fig. 3, it may consist of a closely coiled spiral 13 attached at one end only to a terminal conductor 14.

The envelope 1 is filled with a gas inert with respect to the metal constituting the electrodes. Various indifferent gases, such as nitrogen, argon, or a mixture of these gases, may be used for this purpose, but preferably I employ a vapor, for example, a metal vapor, such as mercury, which renders the arc luminous. In indifferent fixed gases, such as nitrogen or argon, the arc voltage is relatively low, for example, with a slight separation of the electrodes in a lamp filled with an atmosphere of nitrogen having an efficiency of about one-half watt per candle power, an arc may be sustained with an impressed potential of about 50 volts, and under similar conditions in an argon atmosphere an arc may be sustained at about 15 to 20 volts. When using a filling of mercury vapor, furnished, for example, by a globule of metallic mercury 15, there is preferably also present an indifferent gas, such as nitrogen, at relatively low pressure.

The pressure of the gaseous filling preferably is so chosen that at the operating temperature of the lamp, the gaseous pressure is of the order of magnitude of one atmosphere. In the same manner when using a mercury filling, the lamp should be so proportioned as to operate at a temperature at which the vaporized mercury will have a pressure of the order of magnitude of one atmosphere. In some cases, however, the desirable characteristics of the arc may be obtained at lower pressures, at which the arc starts at a lower voltage.

Instead of mercury, other vapors or gases which impart luminosity to the arc may be used, for example, neon, or vaporized salts, for example, thallium tetrachloride (chlorür) or aluminum chloride, either alone, or mixed with one another or with indifferent gases. Oxides such as calcium oxide and magnesium oxide may be placed in the neighborhood of the arc and assist in the production of light either in the solid or vaporized state. Oxides, such for example, as magnesium oxide, aluminum oxide, zirconium oxide and thorium oxide may be admixed with the tungsten constituting the electrodes.

The particular configuration of the electrodes may be varied as desired, but they preferably should be of such dimensions and the connecting conductor should be so proportioned at the point of union with the electrodes that the electrodes will operate at a temperature at which the efficiency of light production by incandescence is higher than at the temperature at which said electrodes could be operated with the same useful life in a vacuum. As the efficiency increases very rapidly with the temperature, a net gain of efficiency may be obtained by operating at higher temperature in an inert gas even though heat is lost by gas convection currents.

Globular electrodes may be made by melting ductile tungsten wires or pressed filament in an arc. The electrodes may also be made by pressing tungsten, or other powder, into desired form and then sintering. Experiments have shown that the diameter of the globules should be about ten times the diameter of the stem. As compared with the stem, the globule has a greater cubical content for its surface. By thus crowding the source of light into a small space, the heat losses to the surrounding gas are materially reduced. Similarly, spirals act, as far as heat losses are concerned, like cylinders of the same size.

In some cases it is preferable to provide the initially heated electrode 6 with a thickened portion or with a globule of metal similar in shape to the cooperating electrode, as shown at 16 in Fig. 4, to prevent over-heating of the spiral conductor. In some cases this small metal button or globule can to advantage be attached to an angle in the heated conductor mechanically or by welding, as shown at 17 in Fig. 5. With such a construction, part of the heated conductor, for example, section 18 operates in series with section 19 only during the starting of the lamp and enables the full working voltage to be employed for starting. During the operation of the arc, section 18 is cut out, section 19 operates in series with the arc and acts as a ballast resistance, thus adding to the efficiency of the lamp, as it may be operated at intense incandescence in an atmosphere of inert gas. The color of the light given by section 19 and the color of the arc can be advantageously made the complement of each other.

The lamps described in connection with Figs. 1 to 5 can be operated on alternating current by first making suitable connections to bring the spiral electrode 6 to incandescence and then applying potential between electrode 6 and the cooperating electrode, for example, electrode 9, Fig. 1, but when direct current is used, care must be exercised to make the heated electrode 6 the cathode.

One method of starting the lamp is shown in detail by Figs. 16 to 19, inclusive. In Fig. 16, the three-point switch 20 is in the off position. As shown in Fig. 17, it first completes a circuit from a source of current represented by the conductors 21 through the conductors 21 to the coiled wire 22. When the coil 22 has been brought to bright incandescence, the switch 20 is turned, as shown in Fig. 18, to connect the cooperating electrode 23 to the positive terminal of the energy supply. As shown in Fig. 19, the next turn of the switch opens the circuit from the current supply through the heated spiral 22 so that an arc springs between the separated electrodes 23 and 24, making the electrode 24 the cathode. It is often advantageous to heat the cathode to a higher temperature at starting than it is heated when the arc is operating, thereby making starting easier.

In Figs. 16 to 19, a separate series resistance 25 is shown in circuit with the electrode 23, but this is unnecessary if the section of heated electrode operating in series with the arc is suitably proportioned to act as a steadying resistance.

The necessity of carefully making the heating electrode the cathode and operating the lamp with direct current makes it desirable in some cases to adapt both electrodes to be heated externally, as shown in Figs. 6 and 7, in which both electrodes 26 and 27, Fig. 6, consist of short heavy spirals of tungsten wire. Of course, in this case thickened portions or globules 28, 29, Fig. 7, may also be provided, located at a shorter distance to each other than the rest of the electrodes so that the arc will have its seat at the thickened portions.

In Figs. 8 to 13, inclusive, various arrangements have been shown in which a heated electrode distinct from the main working electrodes is employed for starting the lamp, this electrode being subsequently cut out of circuit. As shown in Fig. 8, the starting electrode 30 consists of a closely wound spiral similar in construction to the electrode 6, Fig. 1, and located about the same distance from the working electrodes 31, 32, as these electrodes are separated from each other. A heating current is first passed by means of conductors 33 through the spiral 30 and voltage suitable for sustaining an arc is impressed between electrode 30 as cathode and electrode 31 as anode. When electrode 31 has reached bright incandescence, the polarity is reversed so as to make the electrode 31 negative. As the globular electrode 31 has been heated by the arc, it can operate as a cathode. The electrode 32 then is connected to the positive terminal of the energy supply so that when the electrode 30 is disconnected, the arc will spring to the electrode 32 and continue to operate. The construction of Fig. 9 is similar to that already described, except for the shape of the main electrodes 33, 34, which are closely wound spirals similar to the electrode 13, Fig. 3. The main working electrodes 35, 36 in Fig. 10 are shaped hemispherically so that a very short arc may be operated between them. Although for the sake of clearness, the heated electrode 30 of Figs. 8 to 10 has been shown above both the main working electrodes, it may likewise be located in other positions, such as shown in Fig. 11, in which it is positioned vertically. It may also to advantage be located under the arcing electrodes.

The heater wire preferably is so proportioned that the entire voltage utilized in the operation of the lamp can be consumed by the same immediately when switching in the lamp. Thereby an external series resistance otherwise necessary is eliminated. In order to minimize the shock of the initial current through the heater wire, only the part of the heater wire 30 acting directly as electrode may be made of tungsten, the remainder may consist of metal with a smaller temperature coefficient or still better of material with a negative temperature resistance coefficient as carbon or boron. The heating current may be decreased by constituting the heater wire an oxide cathode, for example, as a spiralled or stranded wire, between the turns of which, oxides, such as calcium oxide, have been placed.

When using a starting electrode which is cut out during the operation of the lamp, it is necessary to operate a separate resistance in series with the arc in order to steady the same. This resistance is preferably for the sake of increased efficiency located within the lamp envelope as already described in connection with Fig. 5. In Fig. 12, the resistance 37 has been shown located in series with one electrode and in Fig. 13 two resistances 38, 39 have been shown in series respectively with the two electrodes for the sake of symmetry. The resistances preferably consist of tungsten and are proportioned to operate at a high efficiency. The efficiency and color of the light are thereby improved.

In some cases it is desirable to operate a plurality of arcs in a single envelope, for example, when it is desirable to use higher operating voltages or higher operating currents. In the former case the arcs are operated in series and the latter in parallel. In Fig. 14 an arrangement is shown in which there are provided two heated electrodes 40, 41. Two unheated electrodes 42, 43 are located respectively adjacent to said heated electrodes. A heating current is first passed by means of conductors 44, 45 through the spirals 46, 47 in series and then the arcs are started by a current of suitable potential between electrodes 41, 42 and 40, 43 respectively in a manner already described in connection with the other figures.

In Fig. 15 each of the electrodes is adapted to be heated, the conductors 48, 49 being initially connected to the terminals of the energy supply and the conductors 50, 51 and 52, 53 respectively connected to each other. When thus the entire length of spiral is heated to incandescence, the connections between the conductors 50 and 51 and also between conductors 52 and 53 are successively opened, thereby starting the arcs.

Some of the advantages to be gained with a lamp made as above described are high efficiencies ranging from $\frac{1}{2}$ to $\frac{1}{3}$ watts per candle, the possibility of making high efficiency lamps of low candle power and as contrasted with other arc lamps steadiness of light, absence of regulating mechanism and the fact that no tending or trimming is required.

What I claim as new, and desire to secure by Letters Patent of the United States, is:—

1. An electric arc device comprising the combination of a sealed envelope, refractory metal electrodes therein adapted to operate at incandescence and remaining substantially intact when supporting an arc discharge, and a supply of vaporizable halogen salt having a luminous spectrum for imparting light of desired color to an arc between said electrodes.

2. An electric lamp comprising the combination of a sealed envelope, tungsten electrodes therein adapted to operate at incandescence, and a supply of a vaporizable halogen salt, said salt having a luminous spectrum for imparting light of desired color to an arc between said electrodes.

3. An electric lamp comprising the com-

bination of electrodes of highly refractory metal of low vapor pressure, such as tungsten, at least one of which is adapted to operate at incandescence, a gas indifferent chemically with respect to said electrodes at the operating temperature, and a halogen compound which is gaseous at the operating temperature of the device for imparting luminosity to an arc between said electrodes.

4. An electric arc device comprising the combination of electrodes of highly refractory metal of low vapor pressure, such as tungsten, at least one of which is adapted to operate at incandescence, a gas indifferent chemically with respect to said electrodes at the operating temperature, a supply of aluminum chloride for imparting luminosity to an arc between said electrodes, and an enclosing envelope.

5. An electric arc device comprising the combination of a sealed envelope, tungsten electrodes therein adapted to operate at incandescence, a supply of a halogen compound which is gaseous at the operating temperature of said device and having a luminous spectrum for imparting light of desired color to an arc between said electrodes, and means for operating an arc between said electrodes.

6. The combination of an envelope, main electrodes therein adapted to be heated to incandescence by an arc operating between said electrodes, but not incandescible independently, an auxiliary electrode arranged to be heated by passage of current, gas within said envelope, and connections for operating an arc between said auxiliary electrode and a main electrode preliminary to starting an arc between said main electrodes.

7. An electrical device comprising a sealed envelope, a gas filling therein, main electrodes therein adapted to be heated to incandescence by an arc operating between said electrodes but not incandescible independently, an auxiliary electrode incandescible by passage of current, means for operating an arc between said auxiliary electrode while heated and one of the main electrodes, and means for starting and operating an arc between said main electrode while heated and the cooperating main electrode.

8. An electrical arc device comprising a sealed envelope, main tungsten electrodes therein each comprising a globule mounted on a stem of smaller cross-section, a filamentary electrode adapted to be independently heated, an indifferent gas, means for operating an arc between said filamentary electrode while heated and one of said main electrodes, and means for starting an arc between said main electrodes while the auxiliary arc is operating.

9. The method of starting an arc between cooperating electrodes of refractory material, the cathode not being adapted to be heated independently, which consists in starting an arc between said cathode and an auxiliary electrode which is independently heated and when said cathode is at incandescence impressing a current upon said incandescent electrode and the cooperating electrode, the polarity and voltage of said current being chosen to make said incandescent electrode functionate as cathode.

10. An electric arc device comprising a sealed envelope, main refractory electrodes therein adapted to pass current only through an intervening gap, an auxiliary electrode adapted to be heated independently by passage of current, a gas having a pressure high enough to permit an arc discharge, means for operating an arc between said auxiliary electrode while heated and one of said main electrodes, and means for operating an arc between said main electrodes while the main electrode is heated to incandescence by the arc operating between the same and the auxiliary electrode.

11. An electric arc device comprising the combination of a sealed envelope, electrodes of tungsten therein operating at incandescence, a filling of argon gas and a quantity of aluminum chloride for imparting luminosity to a discharge between said electrodes.

In witness whereof, I have hereunto set my hand this 17th day of September, 1914.

ERNST FRIEDERICH.

Witnesses:

Heinrich Drönner,
Hermann Schröder.

July 17, 1923. 1,461,921

A. LEDERER

ELECTRIC GAS LAMP

Original Filed May 16, 1914

Fig.1.

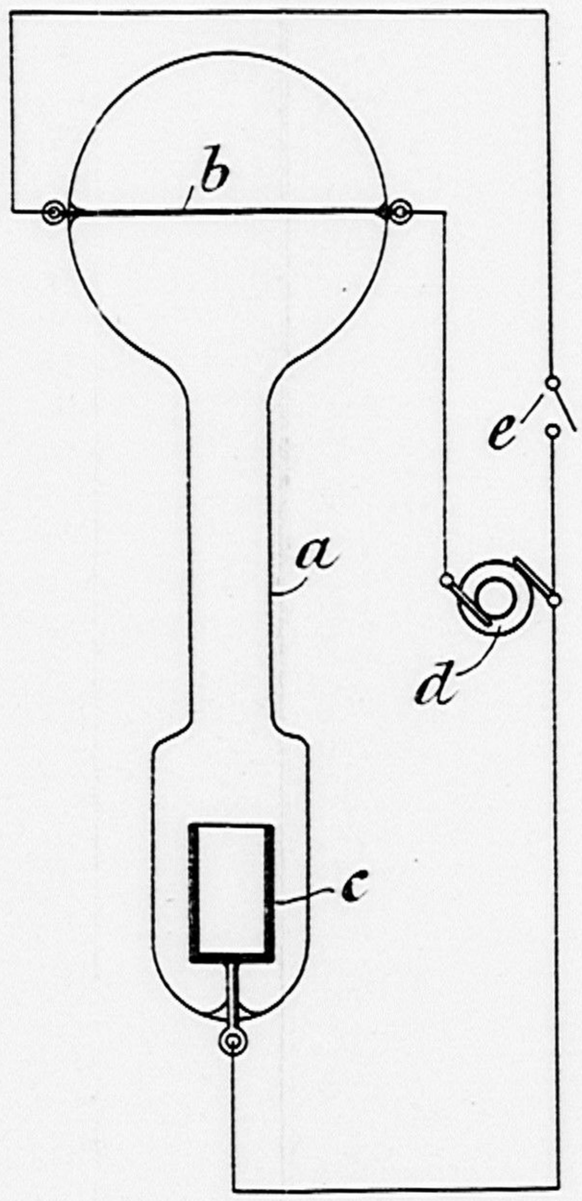
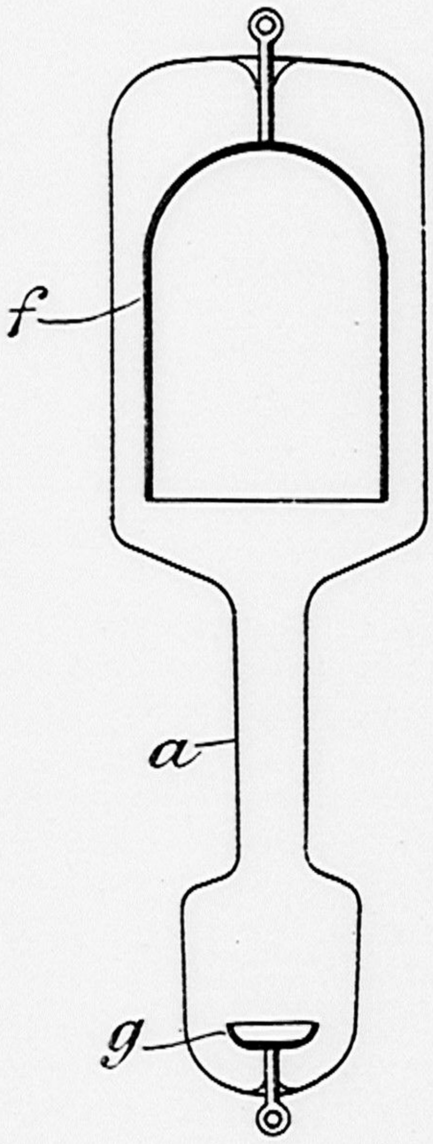


Fig.2.



WITNESSES: INVENTOR:

William P Johnson
S.S. Dunham

Anton Lederer
by his Attorneys,
Kerr, Page, Cooper & Hayward

Patented July 17, 1923. **1,461,921**

UNITED STATES PATENT OFFICE.

ANTON LEDERER, OF VIENNA, AUSTRIA, ASSIGNOR TO WESTINGHOUSE LAMP COMPANY, A CORPORATION OF PENNSYLVANIA.

ELECTRIC GAS LAMP.

Application filed May 16, 1914, Serial No. 839,089. Renewed May 3, 1921. Serial No. 466,400½.

To all whom it may concern:

Be it known that I, ANTON LEDERER, a subject of the Emperor of Austria, and a resident of Vienna, Austria, have invented certain new and useful Improvements in Electric Gas Lamps, and upon which patents have been granted in Austria, No. 72,641, March 15, 1916, and in Germany, No. 291,621, April 25, 1916, of which the following is a specification.

This invention relates to electric gas lamps, that is to say electric lamps in which a gas or mixture of gases, particularly the so called rare gases such as neon, helium, argon, krypton, etc., forms the light giving medium. One lamp of this character has electrodes of an alkali metal potassium for example.

The operation of lamps of this nature with alternating current has proved disadvantageous as compared with direct current for the reason that with direct current a much lower voltage is sufficient—that is to say, in gas lamps of the prior art, the starting voltage is higher than the running voltage whether they be operated on A. C. or D. C. It is also well known that in a given lamp of symmetrical construction the running voltage on an A. C. circuit is higher than the running voltage on a D. C. circuit. The reason for this is that the discharge is extinguished and must be re-established each half cycle and, consequently, required for the lamp when operated on D. C.

According to the present invention, in order to enable electric gas lamps to be economically used with alternating current, a suitable rectifier is embodied in the lamp so that the latter may be directly connected to an alternating current supply. To this end, the so-called Wehnelt electrode (see for instance German Patent #157,845) has proved particularly suitable in this connection and may conveniently be used as one of the lamp electrodes. The same effect may also be obtained by making the electrodes of the lamp itself of different sizes. When connected to an A. C. circuit it will be found that the electrode of larger size will be the positive terminal or anode.

The invention is not restricted to lamps having electrodes of any particular material nor a light giving body consisting of any particular gas, but is applicable to a variety of types of electric gas lamps.

The invention is represented diagrammatically in the accompanying drawings.

In Figure 1 the gas filled envelope or container is indicated at *a* in an upper enlargement of which is located a platinum wire *b* covered with a suitable oxide such as calcium oxide constituting the rectifier element which acts as one of the electrodes of the lamp. In a lower enlargement of the envelope is located the other electrode *c* which may be made of one of the alkali metals such as potassium, sodium or lithium. A source of alternating current is represented at *d* and is connected to the ends of the platinum wire *b* and to the electrode *c* as shown. A switch *e* is provided in one of the leads between the source *d* and the terminals of the wire *b*.

To start the lamp the switch *e* is closed whereupon current flowing through the oxide covered platinum wire will heat it and upon reaching the necessary temperature current will flow through the gas path and electrode *c* to the source *d* after which the switch *e* may be opened and the lamp will continue to operate.

Figure 2 shows a gas lamp having one of its terminals *f* larger than the other *g*. In operation the larger terminal *f* will prove to be the positive terminal or anode.

The lamps described herein may, if necessary, be started by applying a somewhat higher voltage to their terminals than that on which they normally operate.

I claim as my invention:

1. An electric gas lamp, comprising a gas-filled envelope or container, in combination with conducting electrodes, one of which is covered with an oxide and constitutes a negative electron emitter which forms one electrode of a rectifier and the other of which is made of one of the alkali metals, and means for directly passing current through the electron emitting electrode.

2. An electric gas lamp comprising an envelope, an anode consisting of an alkali metal, an electron-emitting cathode, and a filling of a rare gas in said envelope.

3. An electric gas lamp comprising an envelope, an anode of metallic sodium, an electron-emitting cathode, and a filling of a rare gas in said envelope.

4. An electric gas lamp comprising an envelope, an anode of metallic sodium, a metallic oxide cathode, and a filling of a rare gas in said envelope.

5. An electric gas lamp comprising an envelope, a plurality of electrodes, one of which is an electron-emitting element, and a filling of a neon in said envelope.

6. An electric gas lamp comprising an envelope, an anode of metallic sodium, a metallic oxide cathode, and a filling of neon in said envelope.

7. An electric gas lamp, comprising a gas-filled envelope or container, in combination with conducting electrodes, one of which is covered with an oxide and constitutes a negative electron emitter which forms one electrode of a rectifier and the other of which is made of one of the alkali metals, and means for heating the negative electron emitting electrode.

In testimony whereof I have hereunto subscribed my name this fifth day of May, 1914.

ANTON LEDERER.

Witnesses:
A. H. Hopper,
H. B. Green.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,461,921, granted July 17, 1923, upon the application of Anton Lederer, of Vienna, Austria, for an improvement in "Electric Gas Lamps," an error appears in the printed specification requiring correction as follows: Page 1, line 33, after the word "consequently" insert the words *requires a higher running voltage than is;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of October, A. D., 1923.

[SEAL.]

KARL FENNING,
Acting Commissioner of Patents.

52 *Pending Application of Noah C. Pearcy.*

Exhibit No. 1, pages 2 to 8, 9 and 14.
Exhibit No. 2.

Filed February 20, 1924. Serial No. 694,028. For Improvement in Space Current Devices.

53 My invention relates to space-current devices and it has particular relation to devices of the above designated character utilizing thermionic cathodes for maintaining a space current.

One object of my invention is to provide a space-current device having an improved cathode capable of maintaining a large electron emission and which is capable of withstanding the positive-ion bombardment met with in commercial gas-filled rectifiers.

Another object of my invention is to provide an improved thermionic cathode comprising a fused mass of inexpensive metal particles and electron-emitting oxides.

A more particular object of my invention is to provide a thermionic cathode comprising a heater element surrounded by a sleeve of fused nickel and oxides of the alkaline earth metals.

According to my invention, I provide a gas filled rectifier having a cathode which is either directly or indirectly heated and employs as an electron-emitting element a fused mass of nickel and thermionically active oxides, such as barium oxide, strontium oxide and calcium oxide. I thus obtain an electron-emitting element which has very high emissivity and maintains about the same characteristics for a very long time, far exceeding the life and the performance of the ordinary tungsten electrodes.

My invention is particularly well adapted for use in connection with thermionic tubes of the type described in the copending application of H. M. Freeman and W. G. Wade, Serial No. 611,263, filed January 8, 1923 and assigned to the Westinghouse Electric and Manufacturing Company.

Other objects of my invention consist in the provi-

54 sion of new methods of making an improved space-current device and thermionic cathodes of the above designated character.

With the forefoing and other objects in view, my invention consists in the details of structure and methods of construction described hereinafter and illustrated in the accompanying drawings, wherein

Figure 1 is a view in elevation of a rectifier according to my invention with a portion of the front wall broken away to show the inner structure.

Fig. 2 is a similar view illustrating a modification of my invention.

Fig. 3 is a sectional view of a thermionic cathode employed in the space-current device shown in Fig. 1.

Fig. 4 is a view, similar to Fig. 3, showing a modified cathode structure.

Fig. 5 is a diagrammatic view of a rectifier system embodying my invention.

By way of illustration, I have shown my cathode applied to a rectifier, although it is susceptible of other uses, as in three-electrode tubes. Referring to Fig. 1, a rectifier comprises an evacuated envelope 1 having mounted therein an anode 2 and a cathode structure 3 which is supported in a familiar manner by a rod 4 and a terminal strap 6 of metal constituting the electric connection to the cathode. The envelope is preferably filled with a small quantity of inert gas such as argon or mercury vapor for securing an atmosphere of molecules capable of carrying a discharge between the cathode and the anode at relatively low pressures, as is well known in the art.

The principal feature of my invention is the construction of the cathode 3, one modification of which is shown

in Fig. 3 and which comprises a cylindrical member 8 of a refractory insulating material, such as zircon or porcelain, having a heating element 9, of U shape, extending through longitudinally disposed perforations therein. The heating element is supplied with two terminal wires 11, one of which may be connected to the terminal strip 6 leading to the cathode surface. Surrounding the cylindrical member 8 and in close contact therewith is a sleeve 12 comprising a fused mass of metal and oxides of the alkaline earth metals, the sleeve constituting the electron-emitting element 7 of the cathode.

In making the sleeve, I prefer to use nickel on account of its relatively low melting point and since it gives very good performance. As electron emitting oxides, I employ the oxides of barium, strontium and calcium which are fused or sintered with finely divided nickel particles to form a homogeneous mass and which are firmly held to the nickel, assuring a long life and producing a cathode capable of standing the positive-ion bombardment and maintain substantially constant performance throughout the life of the rectifier. The cathode just described is much superior to a cathode structure wherein the high electron emissivity is obtained by dipping a metallic surface in a proper solution for obtaining an oxide coat, since the coat which is obtained by such dipping is destroyed, after a relatively short time, by the bombardment of the positive ions and the tube becomes inoperative after a very short period of operation. Another advantage of my improved cathode is that its construction is much cheaper and consumes only a fraction of the time necessary to make an oxide coated electrode by the dipping process.

One of the novel steps of making an improved cathode

4

56 according to my invention involves the intimate mixture of the

finely pulverized compounds of the alkaline earth metals, and also the employment of finely pulverized nickel. To obtain the finely divided nickel, I take nickel oxide and heat the same in an atmosphere of hydrogen at approximately 600° C. until the oxide is reduced to metal. To obtain the intimate mixture of compounds of the alkaline earth metals used in my improved method of making the cathode, I dissolve a mixture of barium nitrate, strontium nitrate and calcium nitrate in water and precipitate the carbonates of the above-named metals from the solution so obtained, by adding a solution of ammonium carbonate. The precipitate thus obtained, when filtered, washed and dried, constitutes a very intimate mixture of the carbonates of the three metals.

The above-described method of obtaining a pulverized mixture of the compounds of the three metals consists, in general, in dissolving soluble salts of the metals which are to be mixed in a suitable solvent and precipitating from the solution insoluble salts of the metals. In a practical instance, I have used the following proportions:

Barium nitrate, 40%.
Strontium nitrate, 26.67%.
Calcium nitrate, 33.33%.

I regard the above-described step of mixing the ingredients constituting the electron-emitting element of the improved cathode as instrumental in securing the performance of the same and desire that the same be regarded as a distinct feature of my invention.

The nickel particles and the carbonates of the alkaline earth metals are mixed together and moistened with a suitable binder such as water or an acid, such as acetic acid, for example, which reacts with a portion of the carbonates and forms a soluble salt of the alkaline earth metals. I thus obtain a plastic mass which is extruded through a suitable die

5

57 into the desired shape. I may form rods or slabe, or in case of a cathode employed in a rectifier as shown in Fig. 1, I form a cylindrical sleeve which fits over the cylindrical heating element 3.

The extruded body is dried and then heated in an atmosphere of hydrogen to a temperature sufficient to sinter the materials constituting the same. In a practical instance where I use the proportions of the ingredients named above, I bring the heated mass to a temperature of approximately 1000° C.

After removing the sintered body thus obtained from the furnace, the same is ready to be assembled in the space-current device, the carbonates of the alkaline earth metals forming with the nickel, a homogeneous, mechanically strong mass. To carbonates may be reduced to oxides either during the sintering process or at any time afterwards, preferably when treating the tube on the pump in a well-known manner, after the same has been completely assembled.

According to another method, I may form the plastic mass of the nickel particles and the carbonates of the alkaline earth metals into a sleeve surrounding the heater member 3 and introduce the composite body thus obtained into the furnace for carrying out the sintering process as described hereinbefore.

The connection of the electric lead or strip 6 to the cathode may be made either by securing the strip to the cylinder 12 by any mechanical means such as a wire 13 wound around the cylinder or by welding the strap directly to the surface of the cylinder, of by a combination of both methods. The cylinder 12 is secured at its upper end to the holding rod 4, by a strip 14 similar to strip 6 or by any other suitable means.

Rectifiers and tubes made with cathodes obtained in the manner described hereinabove operate very successfully and

6

58 give larger currents at lower voltages than are possible with any other cathode construction of which I am aware. In particular I am able to operate such cathodes in rectifiers without maintaining a current in the filamentary heater 9, as the current therethrough may be turned off as soon as the

current flow through the rectifier is initiated, the bombardment of the positive ions being sufficient to maintain the cathode at a temperature where the same is in an electron-emitting state.

An operative unit of the last described character is shown in Fig. 5. A double-wave rectifier is provided with an improved cathode 13 made according — my invention and two anodes leading to a supply transformer 14. A direct-current load device 15 is connected between the active coat 16 of the cathode and the middle terminal 17 of the transformer 14. The heating filament 18 of the cathode is supplied from an auxiliary transformer winding 19 through a switch 21, which is elect-o-magnetically controlled by the current flowing to the direct current load. The switch is closed when the load current is below a certain value and opened when the current exceeds that value at which the positive ion bombardment maintains the cathode in an electron emitting state.

While a somewhat similar operation of rectifiers has been described heretobefore, I am not aware of any practical construction utilizing a cathode which embodied the oxides of the alkaline earth metals and which was capable of producing a rectifier carrying a large amount of current at the low pressures utilized in my devices. For instance, the electron emission which is obtained by means of my improved cathode is many times larger than the electron emission possible when the cathode consists of a metal bead such as tungsten.

7

59 In Fig. 4 is shown a modification of my invention, the refractory cylinder 3 being coated with nickel or other metal previous to the assembly in the electron-emitting sleeve 12, the whole body being assembled when hot so that the nickel coat is plastic and forms an intimate connection between the sleeve 12 and the refractory heating member 3, facilitating the flow of heat from the heater member to the sleeve and expediting the step of initiating the operation of the rectifier.

I have found that the plastic mass of the nickel and alkaline earth metals may be extruded through a suitable die to form a filament similar to that used in carbon filament lamps. Since the oxides of the rare earth metals are of relatively high resistance and are intermingled with the fine metal particles, a filament so obtained is of relatively high resistance and consumes little current while giving a relatively large electron emission. A filament of this character, when used in a gas-filled tube, is better able to withstand the bombardment of the gas molecules than an ordinary coated filament, and the life of such filament is much longer than can be obtained with other constructions. A tube made according to the last named method is shown in Fig. 4.

A distinct advantage of the filaments and cathodes made according to my invention is that the same are operated at relatively low temperatures and they are less subject to destruction than cathodes operated at high temperatures.

I do not desire to be limited to the precise process and details of construction described hereinbefore, but I desire that the appended claims shall be given the broadcast construction consistent with the prior art.

8

I claim as my invention:

* * * * * * *

Per C. 1 [14, 19].* A thermionic electrode comprising
element including a non-conducting
" A. a heating ∧ member of ∧ refractory material, and
a sintered mixture of metal particles and thermionically active particles in intimate contact with
refractory
" C. said [heating]* ∧ member.

* * * * * * *

" C. 2 [18, 23].* A thermionic electrode comprising
heating element including a
" C. a ∧ substantially cylindrical [heating]* member
of refractory material, and a thermionically
in contact with cylindrical members

[*Words and figures enclosed in brackets erased in copy.]

Per D. active sleeve ^ [surrounding]* said ^ cylinder, said sleeve comprising a sintered mixture of nickel particles and particles of oxides of the alkaline earth metals.

" C. 3 [19, 24].* A thermionic electrode comprising heating element including a

" C. a ^ substantially cylindrical [heating]* member of refractory material, a metallic coating upon

" C. said [heating]* member, a thermionically active in contact with cylindrical members

Per D. sleeve ^ [surrounding]* said ^ [cylinder]* and fused to said coating, said sleeve comprising a sintered mixture of metal particles and thermionically active particles.

B′.

* * * * * * *

9

61 *Amendment, January* 9, 1929.

Hon. Commissioner of Patents,
Washington, D. C.

SIR:

Acknowledging the Examiner's letter of July 19, 1928, please amend the above-entitled application as follows:

Add the following new claim:

E′. —5. An electrical discharge tube enclosing a gaseous atmosphere and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a cintered mixture of metal particles and thermionically active particles.—

* * * * * * *

Respectfully,

WESLEY G. CARR,
Attorney for Applicant.

[*Words and figures enclosed in brackets erased in copy.]

14

62 *Claims* 6 *and* 7 *on Appeal.*

—6. An electrical discharge tube enclosing a gaseous atmosphere of such a pressure that gas ions carry a substantial part of the current, and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles.

—7. An electrical discharge tube enclosing a gaseous atmosphere of such pressure that the discharge is substantially not a pure electron discharge, and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles.—

(Here follows drawing, side folio 63.)

64 [Stamp:] Mailed March 6, 1929.

Div. 54, Rm. 241-A.

Paper #16.

Department of Commerce, U. S. Patent Office,
Washington, D. C.

Before the Board of Appeals on Appeal.

In re Application of Noah C. Pearcy. Serial No. 694,028.
Filed February 20, 1924. For Space Current Device.

March 6, 1929.

Examiner's Statement.

The applicant appeals from the final rejection of claims 1 to 5, inclusive, which are as follows:

1. A thermionic electrode comprising a heating element including a member of non-conducting refractory material, and a sintered mixture of metal particles and thermionically active particles in intimate contact with said refractory member.

694028

Fig. 1.

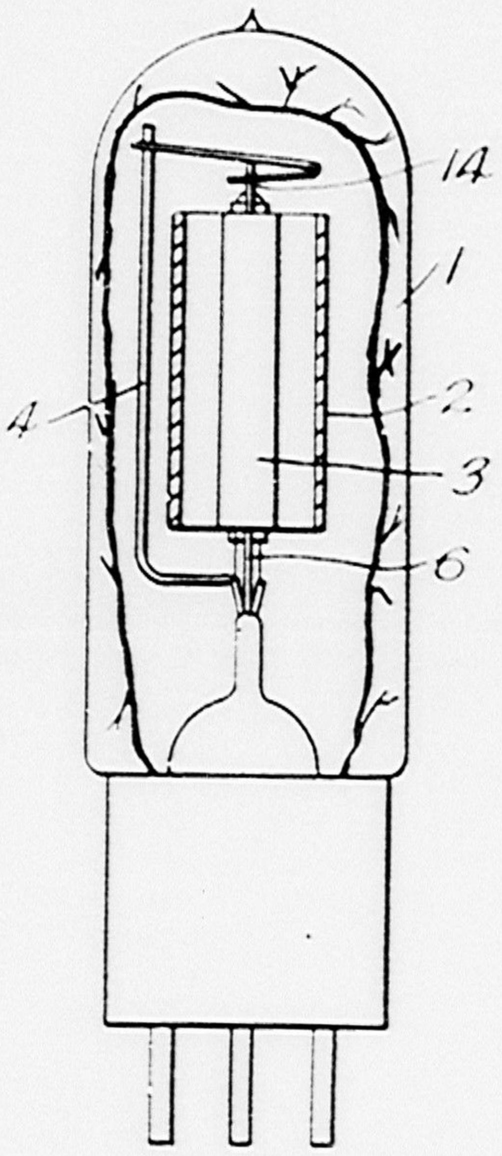


Fig. 2.

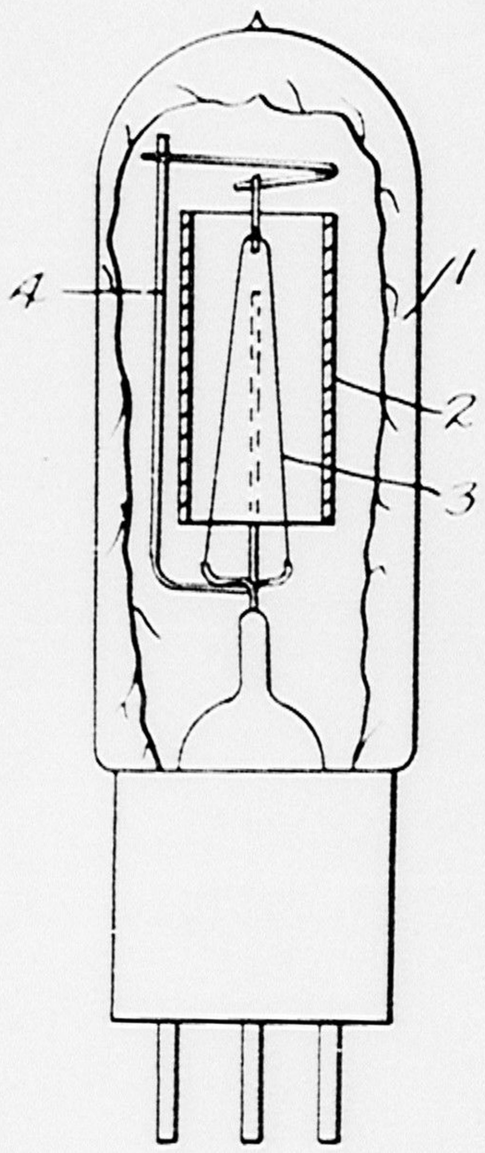


Fig. 3.

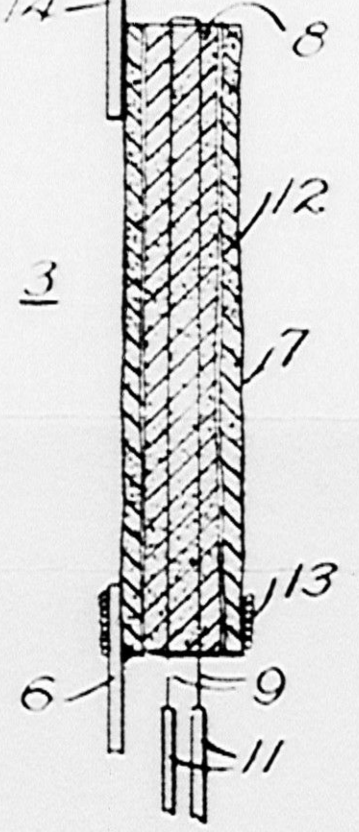


Fig. 4.

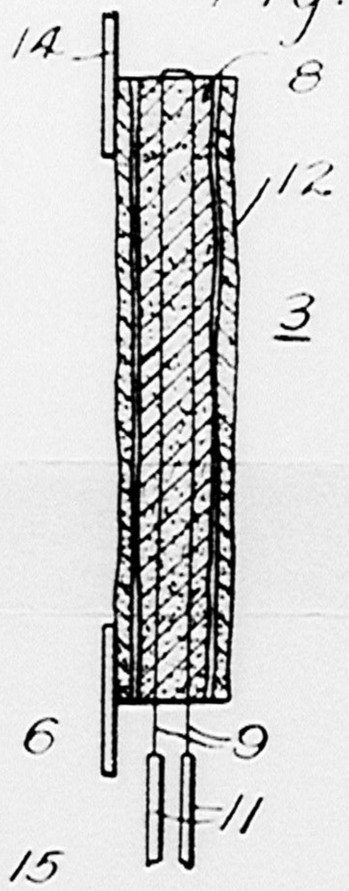
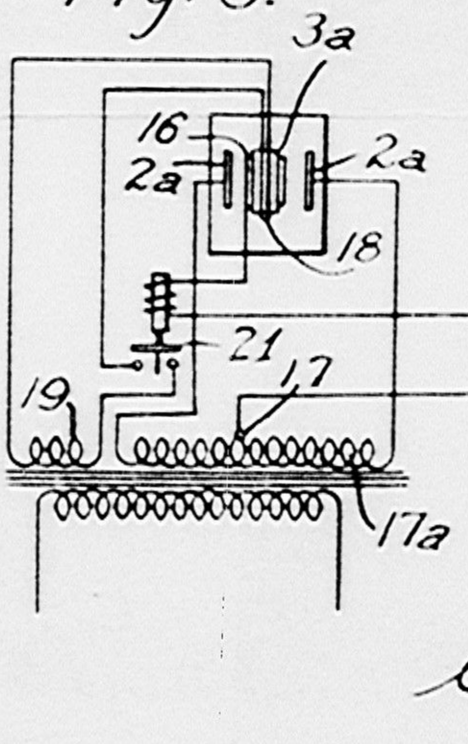


Fig. 5.



WITNESSES:
A. L. Jeffrey
S. M. Pineles

INVENTOR
Noah C. Pearcy
BY
Wesley G. Carr
ATTORNEY

2. A thermionic electrode comprising a heating element including a substantially cylindrical member of refractory material, and a thermionically active sleeve in contact with said cylindrical member, said sleeve comprising a sintered mixture of nickel particles and particles of oxides of the alkaline earth metals.

3. A thermionic electrode comprising a heating element including a substantially cylindrical member of refractory material, a metallic coating upon said member, a thermionically active sleeve in contact with said cylindrical member and fused to said coating, said sleeve comprising a sintered mixture of metal particles and thermionically active particles.

4. A method of forming a cathode for electron discharge tubes which consists of forming a tube of a mixture of which one component is a metal of a high melting point and threading said tube upon a heater comprising a wire of refractory metal.

5. An electrical discharge tube enclosing a gaseous atmosphere and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles.

65 The references relied on are:

Torrisi, 1,368,584, Feb. 15, 1921, 250-27.5-6.4.
Nicolson, 1,169,182, Jan. 25, 1916, 250-27.5-10.
Hocker, 1,459,400, June 19, 1923, 250-27.5-10.
Marden, 1,591,717, July 6, 1926, 250-27.5-10.

Made of record:

Thowless, 844,213, Feb. 12, 1907, 176-131.
"Gas-Filled Thermionic Tubes" by Albert W. Hull, presented at joint New York Meeting of New York Sections of the A. I. E. E. and the I. E. S., May 18, 1928.
Preliminary proof received in Div. 54, June 28, 1928, 250-27.5-6.3.
(The above cited article is not relied on as a reference for any claim, but is cited only to support the argument concerning gas-filled thermionic tubes.)

The applicant discloses a cathode for use in a space current device which employs as an electron emitting element a fused mass of finely divided nickel and alkaline earth oxides.

The cathode 3, as shown in Fig. 3, comprises a cylindrical member 8 of a refractory insulating material as zircon or porcelain, having a heating element 9, of U-shape, extending through longitudinal perforations therein. Surrounding the *cly*indrical member 8 and in close contact therewith is a sleeve 12 consisting of a fused mass of metal particles and oxides of the alkaline earth metals. The sleeve 12 constitutes the electron emitting element of the cathode 3.

In making the cathode 3, the sleeve 12 is formed of finely divided nickel fused or sintered with the oxides of the alkaline earth metals, barium, strontium and calcium, and this sleeve is fitted over the cylindrical insulating element 8.

The patent to Nicolson discloses a cathode 5 for use in an electron emitting device which consists of a heating element 7 threaded through a quartz tube 5, the outer
66 surface of which has a thermionic active coating 6.
The coating 6 is prepared by first forming a platinum deposit on the quartz tube, the platinum deposit being in turn coated with a thermionically active material as a mixture of the oxides of barium and strontium. The platinum deposit on the quartz tube 5 serves as a conductive coating so that the grid element may be biased with respect to the cathode element 6. See page 1, lines 60 to 65 of the patent to Nicolson.

The patent to Hocker discloses a cathode for use in an electron discharge device which consists of a filamentary core of platinum or a suitable platinum alloy with a coating of alkaline earth oxides either singly or in combination impregnated with a finely divided noble metal as platinum, gold, or silver. The electron emitting material is applied to the core material by dipping the core into a solution of the oxides and a chloride of the noble metal which is easily converted to the metal upon being heated, and then baking the coating upon the core material.

The patent to Marden discloses a cathode for use in an electron discharge device which may consist of a core material as tantalum or platinum-iridium with an electron emissive coating of oxides of barium and strontium inti-

mately mixed with finely divided metal as platinum or nickel, or else the filament may be made entirely of electron emissive oxides intimately mixed with a finely divided metal as platinum or nickel. The cathode may be formed by applying a suspension of the mixture of the oxides and
the finely divided metal to the filamentary core ma-
67 terial by any suitable method, as dipping or spraying
and then baking the coating of the filamentary core.
Water or nitro-cellulose dissolved in anyl-acetate may be used as the suspending medium. If the cathode is to be made entirely of the alkaline earth oxides intimately mixed with the finely divided metal (nickel), a paste of the oxides and the metal powder with any suitable binder may be squirted into a filament in the manner similar to that in which squirted tungsten filaments were formerly made, that is the squirted filament could be heated to drive out the binding medium and thereafter raised to a high temperature in an inert atmosphere to cause the particles to sinter. Instead of squirting the filaments, the alkaline earth oxides intimately mixed with the finely divided metal powders may be pressed into a slug and treated in accordance with the method now commonly utilized for treating tungsten and molybdenum, that is the slug could be heated in an inert atmosphere to cause the slug to be sintered and thereafter swaged or rolled to filamentary proportions.

The newly cited patent to Thowless and the patent to Torrisi, cited in the Office action of Sep. 20, 1924, were not used for the final rejection of the claims, but are now added under the provisions of Ex parte Mevey 1891 C. D. 115. Each of the patents are cited to show it to be old to thread a tube of electron emissive material on a heating element.

The patent to Torrisi discloses a cathode comprising a cylindrical nickel tube A, which is platinum plated both inside and out and covered on the outside walls with an electron emissive oxide. The heating element for the cathode element A consists of a rod F of a heat resisting
composition, as porcelain, wound on its tip with a
68 heating coil C with leads E running down the rod F.
The heater element is inserted into the cathode ele-
ment A, and is renewable from the outisde of the discharge device.

The patent to Thowless (Fig. 2) discloses an illuminant for an incandescent lamp comprising a cylindrical non-conductive light-giving body A formed of a material comprising calcium oxide, zirconium oxide, or thorium oxide fitted over a conducting body B formed of a mixture of non-conducting materials and conducting metallic oxides. The light-giving body A is formed into a hollow cylinder and then threaded on the composite conducting body B. See page 2, lines 68 to 74 of the patent to Thowless.

Applicant has merely selected a well known electron emissive material from a directly heated cathode and applied this coating to an indirectly heated cathode. Marden teaches that an electron emissive material comprising a sintered mixture of a finely divided metal as nickel and alkaline earth oxides is capable of being worked into any desired shape and that the emissive material is a conductor of electricity. The patent to Torrisi and the patent to Thowless each discloses it to be old to thread a tube comprising an electron emissive material on a heater element. If it were desired to use the emissive material disclosed by the Marden or Hocker patents in an indirectly heated cathode such as is disclosed by Nicolson, it would involve no more than mere mechanical skill to form the emissive coating to a tube to be applied to the quartz tube 5 of Nicholson.

It is not seen how applicant's emissive material can be more resistant to disintegration in ion bombardment when used in electron discharge devices having a gaseous
69 atmosphere than the emissive material disclosed in
the patent to Hocker or the patent to Marden as these patents disclose the same emissive coating applied to a directly heated cathode as applied by applicant to an indirectly heated cathode. It is well known that any vacuum discharge device must contain some "gaseous atmosphere" and this is particularly true with reference to the devices disclosed by the patent to Nicolson and the patent to Hocker which were filed in 1915 and 1916, respectively, when apparatus for obtaining very low pressures had not yet been developed. Further, the paper by A. W. Hull discloses that any type of cathode can be operated without disintegration in any inert gas, at any pressure between .001 mm. and 5 cm., and with any current up to the maximum vacuum

electron emission of the cathode. See page 1, fourth paragraph of the article by Hull.

Respectfully submitted,

C. H. LANE,
Examiner, Div. 54.

JEL: HC.
J. E. L.

Copy sent: Wesley G. Carr, Patent Dept. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

70 [Stamp:] U. S. Patent Office, Board of Appeals, Apr. 4, 1930, Mailed.

Appeal No. 1435, Paper No. 19.

Appeal No. 1435.
Hearing: Feb. 12, 1930.
MCV.

Decision.

In the United States Patent Office.

Before the Board of Appeals.

Ex Parte NOAH C. PEARCY.

Application for Patent. Filed Feb. 20, 1924. Ser. No. 694,028. Space Current Devices.

Mr. Wesley G. Carr for applicant.

This is an appeal from the final rejection of claims 1 to 5, inclusive.

Claim 1 is illustrative and reads as follows:

> 1. A th*re*mionic electrode comprising a heating element including a member of non-conducting refractory material, and a sintered mixture of metal particles and thermionically active particles in intimate contact with said refractory member.

The references relied upon are:
Nicolson, 1,169,182, Jan. 25, 1916,
Torrisi, 1,368,584, Feb. 15, 1921,
Hocker, 1,459,400, June 19, 1923,
Marden, 1,591,717, July 6, 1926.

Made of record:
Thowless, 844,213, Feb. 12, 1907,
"Gas-Filled Thermionic Tubes" by Albert W. Hull, presented at joint New York Meeting of New York Sections of the A. I. E. E. and the I. E. S., May 18, 1928.
Preliminary proof received in Div. 54, June 28, 1928, 250-27.5-6.3.
(The above cited article is not relied on as a reference for any claim, but is cited only to support the argument concerning gas-filled thermionic tubes.)

Appellant's alleged invention relates to a space current device and particularly to the construction of the thermionic electrode, or cathode, for such space current devices as electron discharge tubes. Said cathode consists of a
71 cylinder or core 8 of refractory insulating material,
such as zircon or porcelain, having a U-shaped heating element 9 extending through longitudinal perforations therein. Surrounding the cylindrical member 8 and in close contact therewith is the sleeve 12 consisting of a fused mass of metal particles, such as nickel, and oxides of the alkaline earth metals, as barium, strontium and calcium.

The Nicolson patent discloses a thermionic translating device having a cathode of similar construction except for the outside coating. His coating 6 is formed by first depositing platinum on the quartz cylindrical core and coating this with a thermionic active material such as the oxides of barium and strontium.

The Marden patent discloses the electron emission material of appellant's coating and uses, either to form the entire cathode or as a coating for a core, material as tantalum or platinum-iridium. Hocker also shows cathodes having a coating of similar material.

We agree with the holding of the examiner that no invention is involved in substituting or perceiving the possibility of substituting the coating of Marden or Hocker in place of the coating of Nicolson for the reasons clearly pointed out by the examiner. This rejection is believed to clearly meet claims 1, 2 and 3.

Claim 4 covers the method of forming appellant's cathode consisting in forming a tube of the mixture and threading it upon the heater element. We agree with the examiner that there is no invention in so forming appellant's cathode in view of the patents to Torrisi or Thowless, particularly the latter.

Claim 5 contains the limitation that the tube in which appellant places his cathode contains "a gaseous atmosphere." The examiner rejected this claim on the references cited against claims 1 to 3, holding that any vacuum discharge device must contain some "gaseous atmosphere" and that this was particularly true at the time the applications of
72 Nicolson and Hocker were filed in 1915 and 1916.

Appellant's argument in which he points out that the references do not specifically mention a gaseous atmosphere has been carefully considered but we find no error in the examiner's action. It is well known that some gas is present even in the most perfect vacuum tubes it has been possible to produce.

In his brief appellant requests us to allow two proposed claims numbered 6 and 7. The first of these is claim 5 with the words—

> of such a pressure that gas ions carry a substantial part of the current

inserted after "gaseous atmosphere." Proposed claim 7 is claim 5 with an analogous insertion.

Appellant states that his tube is intended for use in a rectifier, that a gaseous atmosphere in the tube when used for this purpose is essential and that the cathodes of the references are not adapted for this purpose.

We note that appellant's specification, paper 3, states:

> By way of illustration, I have shown my cathode applied to a rectifier, although it is susceptible of other uses, as in three-electrode tubes.
>
> * * * * * * *
>
> The envelope is preferably filled with a small quantity of inert gas such as argon or mercury vapor for securing an

atmosphere of molecules capable of carrying a discharge between the cathode and the anode at relatively low pressures, as is well known in the art.

Applicant here admits that it was well known in the art that it was desirable to have a small quantity of inert gas in the envelope. This feature was not, therefore, a part of appellant's invention. While he shows his cathode applied to a rectifier, applicant states, *supra,* that it is susceptible of use in three-electrode tubes. Likewise we see no reason why the cathodes of the references are not susceptible of use in the old rectifier tube containing a small amount
73 of inert gas. We do not consider proposed claims 6 and 7 patentable but we have no objection to their admission for purposes of appeal, if appellant so desires.

The decision of the examiner is affirmed.

M. J. MOORE,
Assistant Commissioner,
W. S. RUCKMAN,
Examiner-in-Chief,
EUGENE LANDUX,
Examiner-in-Chief,
Board of Appeals.

April 4, 1930.

74 [Endorsed:] Assembled by L. M. C. Revised by L. M. C. Letter to 129,986. Date: 9/27/32.

Endorsed on cover: District of Columbia Supreme Court. No. 5806. Noah C. Pearcy et al., appellants, vs. Thomas E. Robertson, Commissioner, &c. Court of Appeals, District of Columbia. Filed Oct. 6, 1932. Henry W. Hodges, Clerk.

FOR MR. JUSTICE GRONER

COURT OF APPEALS
DISTRICT OF COLUMBIA
FILED

JAN 3 - 1933

Henry W. Hodges
CLERK

IN THE COURT OF APPEALS OF THE DISTRICT OF COLUMBIA

NOAH C. PEARCY AND
WESTINGHOUSE ELECTRIC &
MANUFACTURING COMPANY
Plaintiffs-Appellants

vs.

THOMAS E. ROBERTSON
COMMISSIONER OF PATENTS
Defendant-Appellee

October Term, 1932,
No. 5806

APPEAL FROM THE SUPREME COURT OF THE DISTRICT OF COLUMBIA

BRIEF FOR PLAINTIFFS-APPELLANTS

WESLEY G. CARR,
Solicitor for Plaintiffs-Appellants.

F. W. LYLE,
Of Counsel.

THE J. W. STOWELL PRINTING COMPANY. FEDERALSBURG, MD.

INDEX

Page
Statement of the Case 1
Subject-Matter of Claims 3
Basis of Rejection of Claims 3
Assignment of Errors 4
Argument 5
The Claims 7
Defendant's Evidence 9
Board of Appeals' Decision 10
Prior Art 15
Further Reference to Assignment of Errors 19
Other Rulings as to Patentability 26
Conclusion 27
Supplement, Ex Parte Irving Langmuir 29

CASES CITED

Woodman vs. Stimpson, 3 Fish. Pat. Cas. 98 .... 21, 24
Webster Loom Co. vs. Higgins, 105 U. S. 580 .... 21, 24
Western Electric Co. vs. La Rue, 139 U. S. 601 22
Potts vs. Creager, 150 U. S. 597 25
Ex parte Irving Langmuir, 10 U. S. Pat. Q. 113 26
General Electric Co. vs. Nitro Tungsten Lamp 266 F. 994 26
Desmond Incandescent Lamp Co. vs. General Electric Co., 27 F2 590; 52 F2 725 26

IN THE COURT OF APPEALS OF THE DISTRICT OF COLUMBIA

NOAH C. PEARCY AND WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY *Plaintiffs-Appellants* *vs.* THOMAS E. ROBERTSON COMMISSIONER OF PATENTS *Defendant-Appellee*	October Term, 1932, No. 5806

BRIEF FOR PLAINTIFFS-APPELLANTS

STATEMENT OF THE CASE

This is an appeal from a decree of the Supreme Court of the District of Columbia in a suit in equity, under Section 4915 R. S. U. S., against The Commissioner of Patents, denying to plaintiffs-appellants Letters Patent for an invention defined in the following claims:

> 1. A thermionic electrode comprising a heating element including a member of non-conducting refractory material, and a sintered mixture of metal particles and thermionically active particles in intimate contact with said refractory member.

2. A thermionic electrode comprising a heating element including a substantially cylindrical member of refractory material, and a thermionically active sleeve in contact with said cylindrical member, said sleeve comprising a sintered mixture of nickel particles and particles of oxides of the alkaline earth metals.

3. A thermionic electrode comprising a heating element including a substantially cylindrical member of refractory material, a metallic coating upon said member, a thermionically active sleeve in contact with said cylindrical member and fused to said coating, said sleeve comprising a sintered mixture of metal particles and thermionically active particles.

5. An electrical discharge tube enclosing a gaseous atmosphere and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles.

6. An electrical discharge tube enclosing a gaseous atmosphere of such a pressure that gas ions carry a substantial part of the current, and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith, said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles.

7. An electrical discharge tube enclosing a gaseous atmosphere of such pressure that the discharge is substantially not a pure electron discharge, and comprising an anode and a thermionic cathode comprising a heating element and a refractory insulating member in good thermal relation therewith,

said insulating member having a coating comprising a sintered mixture of metal particles and thermionically active particles.

Subject-Matter of Claims

The invention described in the application here on appeal is an electrical discharge device, comprising a partially evacuated glass envelope, and a pair of discharge-electrodes comprising a cold anode and a hot (thermionically emissive) cathode.* The latter is of novel character; and, therefore, is properly made the subject matter of claims 1, 2 and 3.

Similarly, claims 5, 6 and 7 define an electrical-discharge tube containing a gaseous atmosphere and the essential elements of a rectifier or other discharge device, one of which is the thermionic cathode defined in claims 1, 2 and 3, the properties and structure of which particularly adapt it for use in a gaseous atmosphere, as will be more fully set forth later in this brief.

Basis of Rejection of Claims

The subject-matter of the rejected claims was held by the Court below to be unpatentable in view of prior art,

---

(Foot-note) *It is doubtless well-known to the Court that electrical discharge devices in extensive use frequently employ one electrode (called a cathode) which is coated with certain oxides having the property of emitting electric charges (electrons) when heated, and of facilitating the maintenance of electric current flow. Ordinary radio tubes are examples, their cathodes comprising fine oxide-coated wires or filaments which are electrically heated. These are satisfactory enough in such tubes, operating, as they do, in high-vacuum and with small load-current, but, in attempting to produce commercial rectifiers, of many times larger output current, appellant found it advantageous to employ a gaseous atmosphere in the envelope, and to support the oxides on a refractory insulator encasing the heater-filament, thereby increasing the area of the heated oxide-cathode to many times that of the heater. Load-current capacity rises if cathode area is increased.

as represented by certain United States patents, copies of which constitute pages 20 to 46 of the Transcript of Record.

ASSIGNMENT OF ERRORS

The Supreme Court of the District of Columbia, in dismissing Plaintiff's bill of complaint, erred in the following particulars:

> 1. In finding that they are not entitled, according to law, to receive a patent for the invention specified in claims 1 to 3 and 5 to 7, inclusive, of application for Letters Patent, Serial No. 694,028, on space current devices, filed February 20, 1924 by Noah C. Pearcy, and in not finding that these plaintiffs are entitled, according to law, to receive a patent for the inventions specified in the said claims 1 to 3 and 5 to 7, inclusive, of the said application for Letters Patent.
>
> 2. In giving undue and improper weight to the prior art adduced by Defendant.
>
> 3. In failing to find that the prior art patents are not entitled to be considered as disclosing the invention disclosed and claimed in the aforesaid application for Letters Patent.
>
> 4. In failing to find that the function of the invention specified in the said claims 1 to 3 and 5 to 7, inclusive, of the said application for Letters Patent was not inherent in, or capable of being effected by, the devices shown in the prior art patents.
>
> 5. In failing to find that the aforesaid application for Letters Patent disclosed novelty in the construction in which the invention specified in the said claims 1 to 3 and 5 to 7, inclusive, of the said application for Letters Patent is embodied; and that the said construction is not anticipated by the prior art patents.

6. In failing to find that the invention would be and/or was involved in combining to produce an anticipation of the combination specified in the said claims 1 to 3 and 5 to 7, inclusive, of the said application for Letters Patents, structural elements shown separately in different prior art patents.

7. In failing to find that such structural elements as the prior art shows were subjected, when in the combination specified in the said claims 1 to 3 and 5 to 7 of the said application for Letters Patent, to conditions so different from those to which they were subject in the combinations in which they are found in the prior art that invention was involved in recognizing their adaptability to produce the results they effect in the combinations specified in the said claims 1 to 3 and 5 to 7.

8. In failing to find that the results produced by the combinations of structural elements specified in the said claims 1 to 3 and 5 to 7 of the said application for Letters Patent are superior to the results produced by any of the combinations shown by the prior art.

9. In dismissing plaintiff's Bill of Complaint and in not sustaining it.

ARGUMENT

So far as can be determined from the Transcript of Record, the Court below accepted the conclusions and supporting reasons of the decision of the Patent Office Board of Appeals as constituting an adequate basis for dismissing the Bill of Complaint.

Such being the case, we ask the special attention of this Court to the evidence offered in the Court below which was not available to the Patent Office Board of Appeals and which, we submit, fully justified a decree for the Plaintiffs.

We do not admit, however, that the evidence before the Board of Appeals constituted an adequate basis for its decision, as will appear later in this brief.

The Patent Office examiners and officials are expert readers of patents but the limitations of their activities are such that they have no expert practical knowledge of the mechanical, chemical and electrical arts which is commensurate with that possessed by engineers who are engaged in designing, constructing and testing devices, apparatus and machines to have more durability in service, to have greater efficiency in operation and to be capable of new or better results, as compared with achievements of the prior art.

Furthermore, it should be, and not infrequently is, recognized by the courts that a claim to patentable novelty is judged after the invention has been made and in the light afforded by later developments in the particular art to which the invention belongs.

Opinions as regards patentability of inventions, when formed ex post facto, may do great injustice which could be avoided if the invention could be judged at the time of its original conception and disclosure.

The evidence before the Court below, which was not available to the Patent Office examiners and the Board of Appeals, is the testimony of Dr. Dayton Ulrey, who earned the degrees of A. B., A. M., and Ph. D. from universities of national prominence and high standing; who taught physics in another university and, for several years, has been a research physicist with the Westinghouse Electric and Manufacturing Company, one of the Appellants (p. 12-Rec.).

The witness was in close touch with the work of Appellant Pearcy, which was supervised by him, and recited some of the difficulties encountered in connection with the experiments which culminated in the invention defined in the claims here on appeal (p. 13-Rec.).

The Claims

1. A thermionic electrode (3) comprising a heating element (8-9) including a member (8) of nonconducting refractory material, and a sintered mixture (12) of metal particles and thermionically active particles in intimate contact with said refractory member.

2. A thermionic electrode (3) comprising a heating element (8-9) including a substantially cylindrical member (8) of refractory material, and a thermionically active sleeve (12) in contact with said cylindrical member, said sleeve comprising a sintered mixture of nickel particles and particles of oxides of the alkaline earth metals.

3. A thermionic electrode (3) comprising a heating element (8-9) including a substantially cylindrical member (8) of refractory material, a metallic coating upon said member, a thermionically active sleeve (12) in contact with said cylindrical member and fused to said coating, said sleeve comprising a sintered mixture of metal particles and thermionically active particles.

5. An electrical discharge tube (1) enclosing a gaseous atmosphere and comprising an anode (2) and a thermionic cathode (3) comprising a heating element (9) and a refractory insulating member (8) in good thermal relation therewith, said insulating member having a coating (12) comprising a sintered mixture of metal particles and thermionically active particles.

> 6. An electrical discharge tube (1) enclosing a gaseous atmosphere of such a pressure that gas ions carry a substantial part of the current, and comprising an anode (2) and a thermionic cathode (3) comprising a heating element (9) and a refractory insulating member (8) in good thermal relation therewith, said insulating member having a coating (12) comprising a sintered mixture of metal particles and thermionically active particles.
>
> 7. An electrical discharge tube (1) enclosing a gaseous atmosphere of such pressure that the discharge is substantially not a pure electron discharge, and comprising an anode (2) and a thermionic cathode (3) comprising a heating element (9) and a refractory insulating member (8) in good thermal relation therewith, said insulating member having a coating (12) comprising a sintered mixture of metal particles and thermionically active particles.

In re-presenting the foregoing claims, we have interpolated, for the convenience of the Court, the reference numerals which are employed in the specification to designate the specified elements of the structure.

It will be noted that each of claims 1, 2 and 3 defines a thermionic electrode comprising certain elements or parts but claim 1 does not specify the form of any of these elements or parts.

Each of the claims 2 and 3, however, specifies that the heating-element refractory member is cylindrical and that the "sintered" mixture of metal particles and thermionically active particles is in the form of a sleeve.

As an additional element, claim 3 specifies a metallic coating (without reference numeral) for the cylindrical member to which the sleeve is fused. This metallic coating is an ancillary feature characterizing the modification of appellant's invention illustrated in Fig. 4 but is not employed in the Fig. 3 modification.

Each of claims 5, 6 and 7 specifies an electrical-discharge tube enclosing a gaseous atmosphere and containing an anode in addition to the thermionic cathode (electrode) defined in claim 1.

Other minor limitations of definition in claims 5, 6 and 7 emphasize functional characteristics which are important and will be discussed subsequently in this brief.

It should be noted that it is the appellant's contention

> (1) that a cathode coating comprising a sintered mixture of metal particles enmeshing the thermionically active particles has properties which particularly adapt it to overcome difficulties originating in properties peculiar to the refractory core on which appellant supports this coating; and
>
> (2) that the properties of such coatings particularly adapt them to overcome difficulties arising from properties peculiar to electric discharges through gaseous atmospheres, as distinct from discharges in high vacuum.

In short, the properties of such coatings and such cores coact or cooperate with each other; and the properties of such coatings and such atmosphere do likewise.

Defendant's Evidence

The evidence offered by the defendant consists solely of U. S. patents, copies of which constitute pages 20 to 46 of the Transcript of Record.

The defense patents will be discussed later in connection with the claims, the decision of the Board of Appeals and the testimony of plaintiff's witness Ulrey.

IN THE COURT OF APPEALS OF THE DISTRICT OF COLUMBIA

NOAH C. PEARCY and
WESTINGHOUSE ELECTRIC
& MANUFACTURING COMPANY,

Plaintiffs-Appellants

-vs-

CONWAY P. COE,
Commissioner of Patents,

Defendant-Appellee

In Equity No. 5806.

MEMORANDUM OF DECISION CITED IN ORAL ARGUMENT

DeForest v. General Electric, 9 Pat. Q. 297, U. S. Supreme Court Case 630, decision dated May 25, 1931.

F. W. Lyle
Attorney for Plaintiffs

October 5, 1933.

Board of Appeals' Decision

The decision of the Board of Appeals makes a fair statement of appellant's invention, as defined in claims 1, 2 and 3 (p. 64-Rec.), except for the use of the word "fused".

The mixed particles of metal and "oxides of the alkaline earth metals" are "sintered"—not fused or melted.

"Sintered" means that the metal particles have been made to adhere together by heating just below melting point without added pressure (p. 13, par. 6-Rec.).

The Board of Appeals' oversight in this particular is an example of other failures to appreciate the full significance and bearing of certain defining terms of the claims, and the following discussion is intended to make clear what the Board disregarded or failed to understand.

With reference to the Pearcy cathode sleeve, Dr. Ulrey says, (p. 14, Rec.):

> "Sintering has several distinct advantages.
>
> (1) It produces a spongy mass in which the barium oxide and strontium oxide particles are imbedded firmly.
>
> (2) The emitting surface is largely increased compared with a solid coating of these oxides by reason of the presence of the pores and interstices.
>
> (3) It has a good thermal conductivity and tends to distribute temperature inequalities and mitigate formation of hot spots.
>
> (4) The additional surface provided by pores and interstices in Pearcy's sintered cathode surface

> constituted an effective electron-emitting surface because Pearcy's tubes were gas filled and would have been ineffective and of no advantage if the tube were of a high vacuum type."

In discussing claims 5, 6 and 7, the Board of Appeals makes the grievous error of ruling that, because no evacuated electrical bulb or tube has a perfect vacuum, Pearcy's electrical-discharge tube containing a substantial quantity of inert gas is not patentably distinguishable from an evacuated tube having a minute quantity of residual gas (air). (P. 65-Rec.)

Dr. Ulrey's testimony sets forth as facts within his personal knowledge, as a research physicist—not as an opinion—that

> "a wide and universally recognized distinction exists between gaseous discharge tubes such as Pearcy's and vacuum tubes such as are universally used in radio receiving sets. Pearcy's gas pressure is 10,000 to 1,000,000 times as high as that of the ordinary radio vacuum tube and such gas as remains in the latter has no effect whatever upon the electrical discharge. In Pearcy's tube, positive ions neutralize what is known as space discharge of the electrons, thus permitting 10 or 20 volts to produce currents of 1 or 2 amperes, whereas the same structure, evacuated as in ordinary radio tubes, could produce even 1/10 of an ampere only under the pressure of 400 or 500 volts. Radio vacuum tubes would cease to function were gas such as Pearcy uses present in them; and Pearcy's tubes would not function for his purposes if he had a vacuum such as that in radio tubes. Radio tubes are invariably high-vacuum

> tubes, since gas, if present, would distort the signals and the tube would be useless. Their characteristics are radically and essentially different from gas-filled tubes and the requirements of the cathode are entirely different, because in the gas filled tube there is a very great tendency to disintegrate the cathode surface due to the positive ions falling into the cathode whereas in a vacuum tube the number of ions falling in is so small as to make this tendency immaterial and not noticeable. The ion bombardment of the cathode in a radio tube is only between one-ten thousandth and one millionth of that on Pearcy's cathode. As far as performance or life of the tube is concerned, we may say there are no ions in the vacuum tube. The loss of emission, therefore, from the cathode in a vacuum tube is from an entirely different reason than the loss of emission in a gas-filled tube''. (p. p. 14 and 15-Rec.)

Again Dr. Ulrey sets forth facts within his knowledge when he says (p. p. 15 and 16-Rec).

> ''any hot spots present on the cathode tend to become exaggerated in a gaseous atmosphere, whereas in a vacuum tube they tend to become minimized. The reason is this: A hot spot in a cathode—and by that I mean some part which is hotter than the rest of it—will give off more electrons than those parts at the lower temperatures, and since they give off more electrons, there is a higher negative charge around them than there is around the remainder, and therefore the positive ions tend to crowd into that area. Since more positive ions will fall into that hot spot, they will make it still hotter, and since making it

hotter, tends to make it give off more electrons, still more will tend to fall into it.

So that there is a condition of unstable equilibrium which is only balanced by the fact that the losses of radiation go up as the fourth power of the temperature. So that finally you get to a condition that the losses by radiation balance the increase in energy due to positive ions falling in, and it does not go farther.

But a cathode which has these hot spots is always one which will give unsatisfactory life as we ordinarily know it, because the evaporation loss of active material is a function of the temperature, and if we go to very high temperatures the life is very short.

Now, in a vacuum tube it is known that the emission of electrons produces a cooling effect, not large but yet measurable. So that the tendency of hot spots to give off more electrons tends to cool that particular spot instead of to heat it; so that you do not have the condition of unstable equilibrium mentioned before.

The presence of a refractory insulator or core, where such is used to support the electron-emissive surface of the cathode, also tends to produce and exaggerate hot spots on the cathode surface, being a poor conductor of heat.

In the Pearcy cathode there is little tendency for hot spots to develop, because of the relatively thick sintered mixture used for the surface. As a refractory insulator would tend to produce hot spots in this surface, the thermal conductivity of the coating

> is such that it will tend to distribute those inequalities and even the temperatures over the surface.''

The decision of the Board of Appeals alleges that

> ''Appellant states that his tube is intended for use in a rectifier, that a gaseous atmosphere in the tube when used for this purpose is essential and that the cathodes of the references are not adapted for this purpose.
>
> We note that appellant's specification, paper 3, states:
>
> By way of illustration, I have shown my cathode applied to a rectifier, although it is susceptible of other uses, as in three-electrode tubes.
>
> * * * * * * * *
>
> The envelope is preferably filled with a small quantity of inert gas such as argon or mercury vapor for securing an atmosphere of molecules capable of carrying a discharge between the cathode and the anode at relatively low pressures, as is well known in the art.'' (pp. 65-66, Rec.).

This allegation appears to imply that Pearcy's contention before the Board ''that his tube is intended for use in a rectifier, etc.'' is vitiated by the statement in his specification that his cathode ''is susceptible of other uses, as in three-electrode tubes''.

Any such implication is unwarranted and without logical basis since the adaptability of Appellant's cathode for use in a three-electrode tube does not prevent it, when used in a gaseous rectifier, from being greatly superior to prior-art three-electrode tube cathodes.

Similarly, the four lines immediately following the above quotation in the Board's Decision seem to imply that because electrical discharge tubes containing gaseous atmospheres were not broadly new, no one could invent a new or improved cathode especially adapted for use in them. This is another clear non sequitur.

Prior Art

Bearing in mind Appellant's contention that it is in (1) mutual and cooperative relation between the properties of a coating of oxides enmeshed in sintered metal and the properties of the refractory core supporting them and in (2) the similar mutual and cooperative relation between the properties of such coating and the properties of a gaseous atmosphere in the discharge tubes, that the effective utility and advantage of his arrangement lie, the following review of the patents upon which the Appellee relies in his defense of this suit shows absence from the prior art of the combinations (1) of such a coating and such a core, and (2) of such a coating and such an atmosphere which must exist if these appurtenant properties are to coact. In this review of the art cited by the Appellee, we can do no better than to rely upon what Dr. Ulrey, a practical expert in this art, says when on the witness stand—

> "Referring to Nicolson patent, No. 1,169,182, (pp. 20-21-22-Rec.) it shows a cathode comprising a refractory cylinder 6, enclosing a heater 7, and provided with an extremely thin coat of platinum somewhat like gold-plating on china, on which is placed a loose coating of barium, strontium and calcium oxides. In contrast to Pearcy's cathode coating com-

prising a 'sintered mixture of nickel with oxide particles' Nicolson's (thermionically emissive) oxides are devoid of any binder and easily rubbed off. Nicolson's tube is a high-vacuum (telephone or radio relay) tube and could not be used for his purposes if gas-filled. Nicolson's thin platinum would have no effect in avoiding temperature inequalities over the cathode surface, whereas Pearcy's thick sintered coating would have a decided temperature equalizing effect. (p. 16-Rec).

Referring to Torrisi patent, No. 1,368,584, it shows a cathode comprising a refractory core, U, provided with a heater, C, and having a nickel coating or sleeve, A, and covered with a 'loose and not adherent' barium-strontium-calcium oxide coating. Torrisi's tube is a high-vacuum tube and would have been useless for his purposes (radio amplifier) if gas-filled.

Both Torrisi and Nicolson fail as anticipations of Pearcy through having—

no sintered mixture of metal particles and thermionically-emissive oxides as cathode surfaces, but only oxides without metal powder mixed in. (p. 16-Rec.)

Hocker patent No. 1,459,400 shows a cathode comprising a filament of platinum coated with particles of barium, strontium or calcium oxides. As an initial step in manufacture, Hocker mixes his oxides with particles of gold, platinum, or iridium, but these are practically completely vaporized by heating and there is when completed no mixture of metal with the oxides. Hocker has no refractory core, no sintered mixture of metal and oxide particles, and has purely a high-vacuum, not a gas-filled tube.

Marden patent No. 1,591,717 shows a cathode comprising a heater-filament coated with a mixture of barium-strontium (thermionically emissive) oxides with metallic (gold, platinum, silver) powder. As an alternative form he describes a cathode comprising a rod forged from the mixed oxide and metal powder, and having no separate heater or core. Marden's cathode was for high-vacuum tubes, and would fail in a gas-filled tube. In the cathode provided with a heater the metal particles are not sintered; the surface would be irregularly, non-uniformly heated and so unlike Pearcy, Marden has no refractory and this results in a voltage-drop from end to end of the cathode which would cause failure in a gas-filled tube. Marden's cathode containing platinum powder would differ radically in a gas-filled tube from Pearcy's sintered nickel powder and would be destroyed by positive-ion bombardment just about as easily as if there is no metal present.

Marden's structure further differs from Pearcy in that the cathode coating of mixed oxides and metal is part of the heater, whereas Pearcy's coating does not function at all as a heater, being insulated from the heater by the refractory core.

Heany patent No. 761,380 shows, not a cathode, but an arc-lamp having electrodes comprising mixtures of particles of noble metal (i. e. gold, platinum, iridium) with some five oxides only one of which is used in thermionically-emissive cathodes and then only in combination with other oxides not disclosed by Heany. His object in using these oxides is to improve the light of the arc by their vapor. His metal particles are not sintered. The electrodes operate in air at atmospheric pressure and the slightest trace of air in tubes of the Pearcy type kills cathode emission and makes the tube practically useless.

Fessenden patent No. 915,280 describes a gas-filled tube intended for receiving the wireless signals of its day (1907) and provided with electrodes coated with barium-strontium (thermionically-emissive) oxides. The device is limited to minute currents, has no mixture of metal particles with the oxides and has no refractory.

Friederich patent No. 1,422,553 describes an arc-lamp having an electrode 6 which can be heated, and states that certain oxides may be placed in the neighborhood of the arc 'in order to improve the light given out.' At another point he describes the mixture of oxides with metallic tungsten constituting the electrode, but none of the oxides so named is thermionically-emissive. He discloses no thermionically-emissive material on the electrodes, nor one admixed or sintered with metal powder; nor any refractory.

Lederer patent No. 1,461,921 shows a vapor-filled arc-lamp having an oxide-coated platinum filament. The cathode coating contains nothing but the usual barium-strontium oxides. There is no refractory, nor any sintered or other metal mixture." (pp. 17-18-Rec.).

Further Reference to Assignment of Errors

Referring again to the Assignment of Errors and, more specifically to No. 7, (p. 9-Rec.).

The Board of Appeals rejected claims 1, 2 and 3 on the ground that,

> ''no invention is involved in substituting or perceiving the possibility of substituting the coatings of Marden or Hocker in place of the coating of Nicolson for the reasons clearly pointed out by the Examiner. This rejection is believed to clearly meet claims 1, 2 and 3.'' (pp. 64 & 65-Rec.)

This finding was, in effect, approved and adopted by the Court below. The ''Examiner's reasons'' thus adopted by the Board were:

> ''Applicant has merely selected a well-known electron emissive material from a directly heated cathode and applied this coating to an indirectly heated cathode. Marden teaches that an electron emissive material comprising a sintered mixture of a finely divided metal as nickel and alkaline earth oxides is capable of being worked into any desired shape and that the emissive material is a conductor of electricity. The patent to Torrisi and the patent to Thowless each discloses it to be old to thread a tube comprising an electron emissive material on a heater element. If it were desired to use the emissive material disclosed by the Marden or Hocker patents in an indirectly heated cathode such as is disclosed by Nicolson, it would involve no more than mere mechanical skill to form the emissive coating into a tube to be applied to the quartz tube 5 of Nicolson''. (p. 62-Rec.)

The last sentence in the foregoing quotation from the Board of Appeals decision is erroneous in statement, because, as Dr. Ulrey testified, Hocker does not disclose a sintered mixture of metal particles and thermionically active particles.

Note lines 87 to 90 of page 2 of the Hocker patent which state that the filament is heated so high as to volatilize all the silver out of the filament.

Other Hocker filaments contained gold oxide, instead of gold metal, (Hocker patent, page 2, lines 25 to 31); while those containing platinum utilize that metal in the form of a thin film produced by ammonium chloroplatinate paste (Hocker patent, page 2, lines 1 to 6).

Substitution of Hocker's coating for Nicolson's would not, therefore, produce the structure defined in claims 1 to 3.

The statement of the Board of Appeals that substitution of the coating of Marden in place of the coating of Nicolson meets claims 1, 2 and 3 is erroneous, because, as Dr. Ulrey has testified, platinum and tantalum particles have a melting point too high to permit sintering, when mixed with alkaline-earth carbonates or oxides and the mixture squirted into filaments (Marden, page 2, lines 20 to 25).

The filaments are not in a "sintered" condition after having been swaged and rolled (Marden, page 2, lines 25 to 38).

Substitution of Marden's coating for Nicolson's would not produce the combinations specified in claims 1, 2 and 3.

The Board of Appeals was in error in stating that no invention is involved in substituting or having the possibility of substituting the coating of Marden or that of Hocker for the coating of Nicolson.

Assuming for the purposes of argument, without admitting, that Torrisi and Thowless severally disclose the threading of an electron-emissive tube on a heater element, and that, if so desired, the Marden or the Hocker material could be embodied in Nicolson's cathode by forming it into a tube and applying it to Nicolson's quartz tube 5; it is error to conclude that no invention is involved in so doing.

It is a settled principle of patent law that, as regards the presence or absence of invention,—

> "The true test is not whether an ordinary mechanic can make the combination, if it is suggested, but whether he would make the combination without suggestion, by means of ordinary knowledge." (Woodman vs. Stimpson, 3 Fish Pat. Cas. 98.)

Where a new combination and arrangement of known elements produces a new and beneficial result never attained before, it is evidence of invention (Webster Loom Company vs. Higgins, 105 U. S., 580).

Refractory cores, such as Nicolson's quartz tube 6, vary considerably in heat conductivity at different points on their surfaces, and so, even in high-vacuum tubes, certain points on their electron-emissive coatings run hotter than other points.

Coatings comprising a matrix of sintered metal in which alkaline-earth particles are imbedded have a relatively high heat conductivity, and, accordingly, tend to minimize, by heat conduction, any inequalites of temperature at different points of the surface.

In contrast to this, the alkaline-earth oxides of Nicolson or those of Torrisi are efficient heat insulators and have comparatively no tendency to equalize temperature differences.

Interspersion of metal into a matrix about the oxide particles is the most effective way of using the high-heat-conductivity metal in temperature equalization. The Pearcy cathode sheath is immeasurably more effective, as a temperature equalizer, than the minutely thin, and, hence, poorly conductive, platinum layer of Nicolson.

The substitution of a sintered coating of the Pearcy type for Nicolson's oxides, therefore, constitutes invention under the Webster Loom Company vs. Higgins decision, supra, even in high-vacuum tubes.

It is further settled patent law that, where references are combined as a basis for rejecting a claim, the element substituted must be the "patentable equivalent" of the element which it replaces; that is to say, it must, in its original sphere of action, perform substantially the same function in substantially the same way as does the element which it replaces when substituted. (Western Electric Company vs. La Rue, 139 U. S., 601). In other words, the mere transfer of an old element from one sphere of action to a similar sphere of action where it performs no new function, is not invention but the promotion of an element to a new sphere of action where it performs a new function is invention.

The function of Nicolson's oxide coating is, in no manner or degree, that of a heater; his only heater being his separate filament 7; whereas, Hocker's filament material is his only heater, and Marden's material, in every case, likewise, acts as a heater.

The function of Pearcy's sintered coating is, accordingly, different from that of Hocker's and Marden's filament materials.

Therefore, under the above-mentioned principle of patent law, no valid finding of non-patentability can be reached legitimately by way of the substitution route.

The conclusion of the Board of Appeals that they "find no error in the Examiner's action" in rejecting claim 5 because any vacuum discharge device must contain some gaseous atmosphere is erroneous.

Dr. Ulrey has testified that a well established distinction exists in the art between "high-vacuum tubes" and "tubes enclosing gaseous atmospheres".

The cathodes of tubes of the two types operate under radically different conditions and, to have long life, must have radically different properties. The tubes of Nicolson and Hocker are "high-vacuum tubes".

Dr. Ulrey's testimony shows that Pearcy's cathode stood up for long periods of time under conditions which caused prompt failure of cathodes similar to Nicolson's. (p. 13-Rec).

The terms of claim 5, accordingly, distinguish from the Nicolson tube and specify a combination adapted to perform functions in high-current rectifiers which the Nicolson tube could not perform, thus defining a new, useful and patentable invention.

It was error to reject claims 6 and 7 on the ground that tubes containing an inert gas are not "a part of applicant's invention" and that there is "no reason why the cathodes of the references are not susceptible of use in the old rectifier tubes containing a small amount of inert gas."

It is settled patent law that a combination which produces a new and useful result is not unpatentable merely because the elements of the combination are separately old.

Furthermore, no addition to the cathodes and tubes of the references (which latter Dr. Ulrey has testified were all high-vacuum devices) of "a small quantity of inert gas" would anticipate the combination of (1) a gaseous atmosphere, (2) a heater and refractory core, and (3) a coating body composed of sintered metal particles and intimately interspered thermionically emissive oxide particles, which claims 6 and 7 specify.

As pointed out above, no combination, even of any two references, anticipates the combination (2), (3) of this claim and, even if it did, such combination of references is in violation of established patent law.

The combination of elements (1), (2) and (3) has been shown by Dr. Ulrey's testimony to produce a commercially improved rectifier, a new result, and the fact that the cathodes of the references are "susceptible" of combination with the elements (1), (2) does not show absence of invention in the combination; (Stimpson vs. Woodman, supra.)

> "Indeed, it often requires as acute a perception of the relations between cause and effect, and as much of the peculiar intuitive genius which is a characteristic of great inventors, to grasp the idea that a device used in one art may be made available in another, as would be necessary to create the device de novo. And this is not the less true, if, after the thing has been done, it appears to the ordinary mind so simple as to excite wonder that it was not thought of before. The apparent simplicity of a new device often leads an inexperienced person to think that it would have occurred to any one familiar with the subject; but the decisive answer is that with dozens and perhaps hundreds of others laboring in the same field, it had never occurred to any one before. The practiced eye of an ordinary mechanic may be safely trusted to see what ought to be apparent to every one. As was said by Mr. Justice Bradley, in Webster Loom Company v. Higgins, (C. D., 1882, 285; 21 O. G., 2031; 105 U. S., 580, 591:)

> Now that it has succeeded, it may seem very plain to any one that he could have done it as well. This is often the case with inventions of the greatest merit. It may be laid down as a general rule, though perhaps not an invariable one, that if a new combination and arrangement of known elements produce a new and beneficial result never attained before, it is evidence of invention.
>
> As a result of the authorities upon this subject, it may be said that, if the new use be so nearly analogous to the former one, that the applicability of the device to its new use would occur to a person of ordinary mechanical skill, it is only a case of double use, but if the relations between them be remote, it may at least involve an exercise of the inventive faculty. Much, however, must still depend upon the nature of the changes required to adapt the device to its new use.'' (Potts vs. Creager, 150 U. S. 597)

The references Friederich and Heany, Dr. Ulrey has testified, show arc-lamps, not thermionic electrodes or thermionic cathodes and fail, both individually and collectively, to meet the terms of the claims here on appeal. Neither these patents nor Fessenden nor Lederer show a refractory core and the two patents last named show no coating mixture of oxides and metal, sintered or otherwise. Appellee has made no attempt to show how the four patents last mentioned anticipate the claims at issue; they are drawn from remote and non-analogous arts and, in the absence of evidence that they anticipate the claims at issue, they should be disregarded.

Other Rulings as to Patentability

Since the refusal to grant a patent upon the Pearcy application here on appeal, the Patent Office Board of Appeals has rendered at least one decision of importance in an analogous case in the specific art to which the Pearcy invention belongs.

We believe that the later decision, to which reference is made above, should be brought to the attention of this Court and, accordingly, we have supplemented this brief with a reprint of the decision as published in 10 U. S. Pat. Q., 113, Ex parte Irving Langmuir.

We submit that, while the Pearcy case and the Langmuir case are closely analogous, the former has the greater patentable merit.

The attention of the Court is also invited to the Langmuir gas-filled tungsten-filament lamp patent No. 1,180,159 and to the Just and Hanneman tungsten filament patent No. 1,018,502 and the Edison gas-filled carbon-filament patent No. 274,295, over which the first named patent has been repeatedly sustained by District Courts and Circuit Courts of Appeals. (General Electric Co. vs. Nitro Tungsten Lamp Co., 266 F. 994; Desmond Incandescent Lamp Co. vs. General Electric Co. 27 F2, 590 and 52 F2, 725).

The above mentioned patent No. 274,295 contributed to the art of electric lighting a hermetically sealed glass bulb and a contained carbon filament (both old) and also a contained body of inert gas (new in that relation).

Patent No. 1,018,502 contributed a hermetically sealed evacuated glass bulb (old) and a contained tungsten filament (new).

The Courts found that Langmuir did something more than an act of mere substitution and that what he contributed was a patentable invention.

Pearcy's contribution to the space-current-device art was more than a mere substitution because it enriched the art by marked functional improvement and because his thermionic cathode was, both structurally and functionally, a new device, and, therefore, patentable.

CONCLUSION

Dr. Ulrey has testified that refractory cores have a tendency to temperature inequalities which the properties of Pearcy's sintered cathode coating mixture have a tendency to eliminate and that no reference shows a cathode coating performing such a function.

Dr. Ulrey has also testified that gaseous electric discharges have a tendency to produce localized overheating of the cathode surface which the properties of Pearcy's sintered cathode coating tend to prevent, and that none of the references show a cathode surface of this type in a gaseous atmosphere or performing this function.

Dr. Ulrey has testified that Pearcy's sintered cathode coating is porous and, by reason of this fact, exposes a larger effective area when used in a gas-filled tube, and that no reference shows a cathode coating performing such a function.

The appellee has introduced no evidence tending to contradict the foregoing evidence in any way.

These are all useful and advantageous functions, and the claims set up the combinations which perform them. That these functions would be effected was so unobvious that it is necessary to consider such recondite matters as non-uniformity of heat conductivity in refractory cores, the tendency to cumulative localized heating which is characteristic of gaseous, but not of high-vacuum, electric discharges, and the ability of gaseous, but not of high-vacuum, discharges to utilize minute cavities in a sponge-like cathode, in order to show and explain their very presence. The claims, therefore, define new, useful and unobvious combinations and are patentable accordingly.

It should be noted that Dr. Ulrey's statements stand uncontradicted by any witness for the Appellee, or otherwise, and neither their truth nor accuracy was impeached under the cross-examination by appellee's counsel.

None of the patents discussed by Dr. Ulrey disclosed the sponge-like structure embodied in Pearcy's coating after sintering.

None of the thin coatings described in the reference patents would tend to distribute inequalities and even the temperature of the cathode surface, as would Pearcy's thick sintered coating, because thermal conduction is a function of thickness of material.

The sintered nickel particles adhere and hold the oxide particles in place; and none of the reference patents have similar mixtures, since their metals do not sinter and, therefore, would have no effect in holding the oxide particles.

In other gaseous tubes, the ionic bombardment disintegrates the cathode and makes it wear out quickly, while, in the Pearcy tube, the sintered nickel enmeshes the oxides and withstands this bombardment and stands up much longer than the other tubes tested by Pearcy before producing the one in suit.

No reference shows a cathode comprising the combinations (1) of a sintered oxide and metal coating with a refractory core or (2) of such a cathode coating with a gaseous atmosphere. Yet, it is these combinations which are necessary to invalidate Pearcy's claims.

Respectfully submitted,

WESLEY G. CARR,
Solicitor for Plaintiffs-Appellants.

F. W. LYLE,
Of Counsel.
December, 1932.

SUPPLEMENT

Ex Parte Irving Langmuir
Patent Office Board of Appeals.
Appeal No. 2751.

Patent No. 1816682 was issued July 28, 1931 for Electron Discharge Devices, on application filed March 10, 1926, Serial No. 93727. Opinion dated January 28, 1931.

Charles E. Tullar for applicant.

Before Kinnan, First Assistant Commissioner, and Landers and Pierce, Examiners in Chief. (10 U. S. Pat. Q., 113)

OPINION OF THE BOARD

Kinnan, First Assistant Commissioner.—The applicant has appealed from the decision of the examiner denying the patentability of claims 5 and 6. Claim 5 is illustrative and is as follows:

> 5. The combination of means for generating an electron discharge accompanied by an amount of positive ionization which is insufficient to materially neutralize space charge, means for trapping positive ions in the discharge space and magnetic means for varying the effectiveness of said trapping means.

The references relied upon are: Alexanderson, 1535082, April 21, 1925; Hull, 1387985, August 16, 1921; Kingdon, 1579117, March 30, 1926.

The claims are directed to an electron discharge tube of the high-vacuum type and in which a slight amount of residual gas is intentionally permitted to remain in the tube to the end that positive ions may be formed for neutralizing the negative space charge set up by the electrons in their travel from the cathode to the anode. The cathode is in the form of a filament while the anode is of cylindrical form and surrounds the cathode.

At each end of the cylindrical anode, an end plate is provided spaced from the anode, and these plates on being positively charged act to repel the positive ions which are thus confined or trapped in a restricted space in the region of the cathode.

APPARATUS IDENTICAL

The apparatus is substantially identical with that disclosed in the patent to Kingdon and there is no contention on behalf of the applicant to the contrary. The claims under review depend for their novelty upon the "magnetic means for varying the effectiveness of said trapping means" (claim 5), or as more broadly stated in claim 6, "means for imparting to ions in said space an angular momentum about said cathode."

The applicant sets forth that the employment of this magnetic field serves to greatly enhance the space charge reducing effect obtained by Kingdon to the end that the tube may carry materially larger amounts of current for the same voltage loss and increase the efficiency of operation.

The patents to Hull and Alexanderson disclose substantially, and this is more particularly true of the Hull patent, the means employed by the applicant to produce this magnetic field within the tube. The examiner has held that since in discharge tubes of this type there is necessarily some residual gas present in spite of very great efforts to eliminate it, there would be some ionized gas in the Hull and Alexanderson tubes and the magnetic fields created by the surrounding coils of these devices would produce something of a trapping effect and give some angular momentum to the ions.

Upon this view the examiner has held there was nothing inventive in employing the Hull coil about the Kingdon discharge tube rightly stating that if this were done the claims would be fully anticipated.

It is submitted on behalf of the applicant that neither Hull nor Alexanderson makes any statement in support of the view that there is any such effect produced by the magnetic field and that these discharge tubes do not disclose the means for trapping the ions adopted by applicant nor any means at all for producing such trapping effect.

UNAWARE OF RESULT

In consequence, these patentees do not disclose and were unaware of such result, and since the employment of the magnetic coil with the Kingdon device produces a new result by reason of the presence of the combination of trapping plates and magnetic field, the claims should be allowed. It is further urged on behalf of the applicant that Hull and Alexanderson were concerned with the effect of the magnetic field upon the electrons rather than upon the ions and they were unaware of any effect of the field upon ions even if effect could be held to be present.

The magnetic field provided by the applicant is claimed to prevent some of the positive ions from striking the filament which, since there is present some considerable number of ions, would otherwise strike the cathode. The improved result of the trapping plates is to increase the number of ions in the region of the cathode since the plates repel the ions along the cathode, and this results in a substantial reduction of the space charge to a greater degree than could be secured by the Kingdon disclosure, which did not utilize the magnetic field.

We agree with the applicant that there was an improved result obtained by employing the magnetic field with the trapping plates and that there is nothing in the Hull or Alexanderson patent to suggest that such a field could be used with the Kingdon discharge tube and this improved result obtained. We think claim 5 should be allowed, and we regard claim 6 as patentable if some indication of the nature of the means for giving the ions their angular momentum is recited.

We suggest the word magnetic be added before "means" in the last clause of the claim. There is no disclosure of any means other than magnetic or electric and we are not aware of any other means which would produce this result. In re Tucker and Reeves, C. C. P. A., January 21, 1931 (not yet published). This claim 6 is regarded as too broad in view of the disclosure, but, as above indicated, we deem it not anticipated by the prior art.

The decision of the examiner is reversed as to both claims, but we recommend claim 6 be denied on the ground we have noted, and allowed if amended as we have indicated.

COURT OF APPEALS
DISTRICT OF COLUMBIA
FILED

JAN 26 1933

Henry W. Hodges
CLERK

No. 5806

In the Court of Appeals of the District of Columbia

NOAH C. PEARCY AND WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, APPELLANTS

v.

THOMAS E. ROBERTSON, COMMISSIONER OF PATENTS, APPELLEE

BRIEF FOR THE COMMISSIONER OF PATENTS

T. A. HOSTETLER,
Solicitor United States Patent Office.

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v.
THOMAS E. ROBERTSON, COMMISSIONER OF PATENTS, appellee

BRIEF FOR THE COMMISSIONER OF PATENTS

This is an appeal by Plaintiff-Appellant from a decree of the Supreme Court of the District of Columbia dismissing plaintiffs' Bill of Complaint filed under Section 4915 R. S.; 35 U. S. C. A. 63.

The seven claims denied appellant appear in the Bill on pages 2 to 4 of the record. Claim 4 was withdrawn at the trial and is not included among the other claims on page 7 of appellant's brief.

Claim 2, which is illustrative, reads as follows:

> 2. A thermionic electrode comprising a heating element including a substantially cylindrical member of refractory material, and a thermionically active sleeve in contact with said cylindrical member, said sleeve

> comprising a sintered mixture of nickel particles and particles of oxides of the alkaline earth metals.

The principal references relied upon are:

> Nicolson, 1169182, Jan. 25, 1916.
> Torrisi, 1368584, Feb. 15, 1921.
> Hocker, 1459400, June 19, 1923.
> Marden, 1591717, July 6, 1926.
> Fessenden, 915280, March 16, 1909.

APPELLANT'S DISCLOSURE

Appellant discloses a space-current device or tube having a thermionic cathode electrode. The electrode comprises a heating element consisting of a cylindrical member 8 of refractory material, through which a U-shaped heating filament extends. Surrounding the cylindrical member 8 is a sleeve 12, which, as stated at the bottom of page 49 of the record, comprises.

> * * * a fused mass of metal and oxides of the alkaline earth metals, the sleeve constituting the electron-emitting element 7 of the cathode. In making the sleeve, I prefer to use nickel on account of its relatively low melting point and since it gives very good performance. As electron-emitting oxides, I employ the oxides of barium, strontium, and calcium, which are fused or sintered with finely divided nickel particles to form a homogeneous mass and which are firmly held to the nickel, assuring a long life and producing a cathode capable of standing the positive-ion bombardment and maintain sub-

stantially constant performance throughout the life of the rectifier.

The specification also states at the top of page 49 of the record:

> By way of illustration, I have shown my cathode applied to a rectifier, although it is susceptible of other uses, as in three-electrode tubes.

THE REFERENCES

The patent to Nicolson, No. 1169182 (R. 20), discloses a cathode 5 for use in an electron emitting device which consists of a heating element 7 threaded through a quartz tube 5, the outer surface of which has a theromionic active coating 6. The coating 6 is prepared by first forming a platinum deposit on the quartz tube, the platinum deposit being in turn coated with a thermionically active material as a mixture of the oxides of barium and strontium. The platinum deposit on the quartz tube 5 serves as a conductive coating so that the grid element may be biased with respect to the cathode element 6. See page 1, lines 60 to 65 of the patent to Nicolson.

The patent to Torrisi, No. 1368584 (R. 23) discloses a cathode comprising a cylindrical nickel tube A, which is platinum plated both inside and out and covered on the outside walls with an electron-emissive oxide. The heating element for the cathode element A consists of a rod F of a heat-resisting composition, as porcelain, wound on its tip with a heating coil C with leads E running down the rod F. The heater element is inserted into the cathode element A, and is renewable from the outside of the discharge device.

The patent to Hocker, No. 1459400 (R. 25) discloses a cathode for use in an electron-discharge device which consists of a filiamentary core of platinum or a suitable plantinum alloy with a coating of alkaline earth oxides either singly or in combination impregnated with a finely divided noble metal as platinum, gold, or silver. The electron-emitting material is applied to the core material by dipping the core into a solution of the oxides and a chloride of the noble metal which is easily converted to the metal upon being heated, and then baking the coating upon the core material.

The patent to Marden, No. 1591717 (R. 29) discloses a cathode for use in an electron discharge device which may consist of a core material as tantalum or platinum-iridium with an electron emissive coating of oxides of barium and strontium intimately mixed with finely divided metal as platinum or nickel, or else the filament may be made entirely of electron emissive oxides intimately mixed with a finely divided metal as platinum or nickel. The cathode may be formed by applying a suspension of the mixture of the oxides and the finely divided metal to the filamentary core material by any suitable method, as dipping or spraying and then baking the coating of the filamentary core. Water or nitro-cellulose dissolved in anyl-acetate may be used as the suspending medium. If the cathode is to be made entirely of the alkaline earth oxides intimately mixed with the finely divided metal (nickel), a paste of the oxides and the metal powder with any suitable binder may be squirted into a filament in the manner similar to that in which squirted tungsten filaments were formerly made, that is the squirted filament could be heated to drive out the binding medium and thereafter raised to a high temperature in an inert atmosphere to cause the particles to sinter. Instead of squirting the filaments, the alkaline earth oxides intimately mixed with the finely divided metal powders may be pressed into a slug and treated in accordance with the method now commonly utilized for treating tungsten and molybdenum, that is the slug could be heated in an inert atmosphere to cause the slug to be sintered and thereafter swaged or rolled to filamentary proportions.

The patent to Fessenden, 915280 (R. 35) discloses and claims a gas-filled tube. Fessenden states on page 1 of his specification (lines 39–44) that he uses a—

> * * * vacuum tube 13, which may be of any desired shape, and may contain any suitable gas such as hydrogen, nitrogen, helium, argar, neon, etc., the ones named of the helium group having been found especially advantageous. (R. 36.)

The electrodes 15 and 16 of Fessenden are disclosed as being cold electrodes, whereas electrode 14 is evidently a cathode "of such material as iridium or aluminum and they may be covered with an oxide of calcium or its equivalents barium or strontium." (Page 1 of patent, lines 101–104.) That this cathode is indirectly heated is made manifest in lines 71–74 of Fessenden wherein we find that oxide coated cathode "14 is shown heated by coil 32 excited by battery 26 * * * the heat being projected by a reflector 33." This clearly discloses the broad combination of an electric discharge tube filled with an ionizable gas (as identified above) and housing electrodes, one of which is an indirectly heated oxide-coated cathode.

ARGUMENT

Claims 1, 2, and 3 are for a thermionic electrode while claims 5, 6, and 7 are for the vacuum tube as a whole, including the thermionic electrode (cathode) as an element.

The first question that presents itself is whether appellant made any invention in selecting the particular material for his electron-emitting element. To construct this element appellant utilizes a metal with which he fuses (R. 47) certain oxides of alkaline earth metals, as is well known in the electron-emitting art. As a metal appellant uses nickel. As oxides he suggests barium oxide, strontium oxide, and calcium oxide (R. 49). These materials are shown to be old in such uses in the prior art patents of record. Marden (R. 29) suggests various metals including nickel (line 80) and the same oxides (line 84) as appellant, i. e., "a mixture of the oxides of barium and strontium or the carbonates thereof."

As appears from lines 53 to 70 (R. 29) of the Marden patent, Marden recognized the defects of prior practice and solved the problem as indicated in lines 71 et seq. of that patent.

Nicolson forms a platinum deposit on the tubes 5 that surround the filament, which tube in turn is coated with oxides of strontium or barium or other suitable thermionically-active material.

As the claims do not specifically claim the metal used nor the specific oxides it is not necessary to further compare appellant's disclosure with the references as to the material used.

Reading claim 1 on the Nicolson patent we find in that patent a thermionic electrode (device) comprising a heating element (filament 7 and tube 5) "including a member" (tube 5) of nonconducting refractory material. The metal and thermionically-active material are indicated at *6*. This coating however differs in that the metal and oxides are separately applied and not mixed. Marden however discloses that the metals and oxides may be applied to the filament when "sintered" (R. 30, line 121) or may be baked thereon (line 76). Obviously claim 1 discloses no patentable novelty over the disclosures of the Nicolson and Marden patents.

As to claims 2 and 3, that include sleeve 12, its equivalent is found in the coating disclosed by Marden in the structure defined in lines 83 et seq. (R. 30) as follows:

> One or more coatings of the suspension may be applied to the filamentary material, depending on the thickness of the coating desired thereon. Filamentary material, coated as aforedescribed, permits the use of a thicker coating than if no metal were mixed with electron-emitting oxides, because the metal powder in the coating serves as a conducting medium to bring the electrons to the surface, the electron-emitting oxide serving merely as the final gate-way by means of which the electrons are discharged.

It is apparent that the quoted structure is the full equivalent of the sleeve and mixture recited in claims 2 and 3.

Claims 5, 6, and 7 include the vacuum tube enclosing a gaseous atmosphere in combination with cathode of claims 1, 2, and 3. Nicolson, Torrisi & Hocker each disclose a vacuum tube and the Marden device is intended to be used in a vacuum tube. Nothing further therefore need be said on that feature, i. e., the glass enclosing shell or vacuum tube. This leaves for consideration only the "gaseous atmosphere."

It is possible that the record may give the impression that the appellant's tube or envelope is so full of gas as not to be a vacuum tube at all. The specification states (R. 49) that "The envelope is preferably filled with a small quantity of inert gas such as argon," etc. What is the condition of an enclosed vessel filled with gas? In other words, how much gas is required to fill a vacuum tube with gas? The molecules of gas under the kinetic theory of gases repel each other. It is therefore a law of physics that, "However small their quantity, gases always fill the vessels in which they are held." This means, of course, that the vessel is empty or evacuated. This explains why it is almost impossible to obtain a perfect vacuum.

No matter how small the quantity of gas appellant admits to the tube or envelope it always fills the tube on account of the repellant action of the molecules. The gas is in a rarefied or attenuated condition.

Was appellant the originator of the idea of using a small quantity of gas in this art? In answer to the question we quote from the bottom of page 62 of the record as follows:

> * * * Further, the paper by A. W. Hull discloses that any type of cathode can be operated without disintegration in any inert gas, at any pressure between .001 mm. and 5 cm., and with any current up to the maximum vacuum electron emission of the cathode.

Further quotation is made from page 66 of the record as follows:

> Applicant here admits that it was well known in the art that it was desirable to have a small quantity of inert gas in the envelope. This feature was not, therefore, a part of appellant's invention. While he shows his

> cathode applied to a rectifier, applicant states, supra, that it is susceptible of use in three-electrode tubes. Likewise we see no reason why the cathodes of the references are not susceptible of use in the old rectifier tube containing a small amount of inert gas.

It is well known that practically all vacuum discharge devices contain some "gaseous atmosphere" and this is particularly true with reference to the devices disclosed by the Nicolson and the Hocker patents, applications for which were filed in 1915 and 1916, respectively, when apparatus for obtaining very low pressures had not been in commercial use. The gas left or injected into the tube must be an inert gas, otherwise the filament when heated to incandescense would burn up.

Claims 5, 6, and 7 are for substantially the same specific cathode claimed in rejected claims 1, 2, and 3, included with an anode in a gas filled tube, no specific pressure of gas being claimed. Accordingly, claims 5, 6, and 7 fall as claims 1, 2, and 3 in view of Fessenden, who shows the broad combination as explained above. He discloses an electric discharge tube 13 enclosing a gaseous atmosphere (especially those of the helium type) and comprising an anode 15 or 16, and a thermionic cathode. The specific thermionic cathode was treated in the discussion of why claims 1, 2, and 3 are unpatentable.

Appellants on page 10 of their brief criticize the Board of Appeals in the use of the word " fused."

The brief there states that the mixed particles of metal and oxides are sintered, not fused or melted. The brief is obviously incorrect as the specification (R. 47) at the middle of the page, refers to the cathode as "comprising a fused mass," which statement is in substance repeated in the last six lines of that page, and again at the bottom of page 49. Near the top of page 50 it is stated that the oxides may be *fused or sintered* with finely divided nickel particles.

Where there is a conflict between the specification and the brief or the testimony it is the specification that governs.

Dr. Ulrey's testimony that Pearcy's gas pressure is 10,000 to 1,000,000 times as high as that of the ordinary radio vacuum tube (Brief p. 11, lines 18 to 20) appears to have no foundation in appellant's specification. In order to compare two different pressures and conclude that one "gas pressure is 10,000 to 1,000,000 times as high as that of the other" it is necessary that both of said two different pressures be given quantitatively. If one of these is not given quantitatively it follows that their ratio can not be found. One of these gas pressures should be that of Pearcy's tube. But Pearcy, in his specification, fails to give any quantitative pressure. No definite or measured pressure is disclosed. He merely states that "the envelope is preferably filled with a *small quantity* of inert gas * * * at relatively low pressures, as is well known in the art." (Brief, p. 49, lines 24–29.)

It is clear that no definite numerical value can be found from such a statement. Nowhere in the appellant's specification is it found that he gives any numerical values for the pressure of the gas in his tube. Accordingly the ratio of Pearcy's gas pressure to "that of the ordinary radio vacuum tube," in so far as this application is concerned, is indeterminate and the asserted value of "10,000 to 1,000,000 times" must be discarded for lack of foundation in the specification.

It is submitted that the claims are for a combination of elements producing no new result over what is shown in the art and are therefore unpatentable under the authority of *Edwards* v. *Dayton Mfg. Co.*, 257 F. R. 980, 1919 C. D. 357, and the decisions therein cited.

It is respectfully submitted that the decree of the Court below is correct and should be affirmed.

T. A. HOSTETLER,
Solicitor for the Patent Office,
Attorney for Appellee.

JANUARY 23, 1933.

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